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EDITOR'S NOTE

Before you throw out that to-go container, imagine its contents powering your home. In places like Copenhagen, waste-to-energy plants are already performing this sort of alchemy, but a true transformation could be catalyzed by designing a more intimate relationship with waste. It's this magical thinking that is propelling chefs, designers, urban planners, scientists and engineers to consider the myriad ways that food waste is a resource.

The numbers from the UN Food and Agriculture Organization are daunting: one third of the food we produce (about 1.3 billion tons) is wasted every year. In places like Europe and North America, this represents a mass equivalent to two grown adults (about 240 pounds) per person per year getting binned. While the financial cost is great—in industrialized countries a cool $680 billion—the greater tragedy is that we could feed all of the world's 815 million chronically hungry people by saving just one quarter of global food waste.

Examples of how and where food waste occurs are numerous; it is a persistent weed in our food system. Its roots are plentiful: issues with logistics, habits, politics and failures of imagination all render inedible the edible. Not only does food waste represent lost nutrition and calories, but it hijacks invaluable resources that have gone into producing, distributing and storing it. With a ballooning global population of 9 billion people expected by 2050, managing food waste stands as one of the most pressing challenges, and potential solutions, in trying to attain food security for all. But, as Natsai Chieza reminds us in this issue, a weed is merely a plant out of place.

Issue 3 celebrates "waste" as resource in a closed-loop, networked economy through the lenses of food preservation, material futures and dignity for the hungry. We believe that this approach will bridge current conversations around sustainability with future solutions built around resiliency.

From redesigning our relationship with our tiniest microbial collaborators to shaping future cities, food waste plays a key role. Dr. Suzanne Pierre takes a magnifying glass to composting and the environmental promises of returning carbon to the soil, while noma chef David Zilber calls for an interdisciplinary approach beyond fermentation. Anthropologist Paula Petkova rallies architects to translate waste reduction practices into our built environment. And what better to build with than food waste? Marta Giralt maps the ways designers are treating food waste as a material to be mined and harvested, artist/designers Chieza and Mike Thompson explain how to build a fatberg, and we profile companies transforming landfill into scalable solutions for making biofuel and reducing postharvest spoilage.

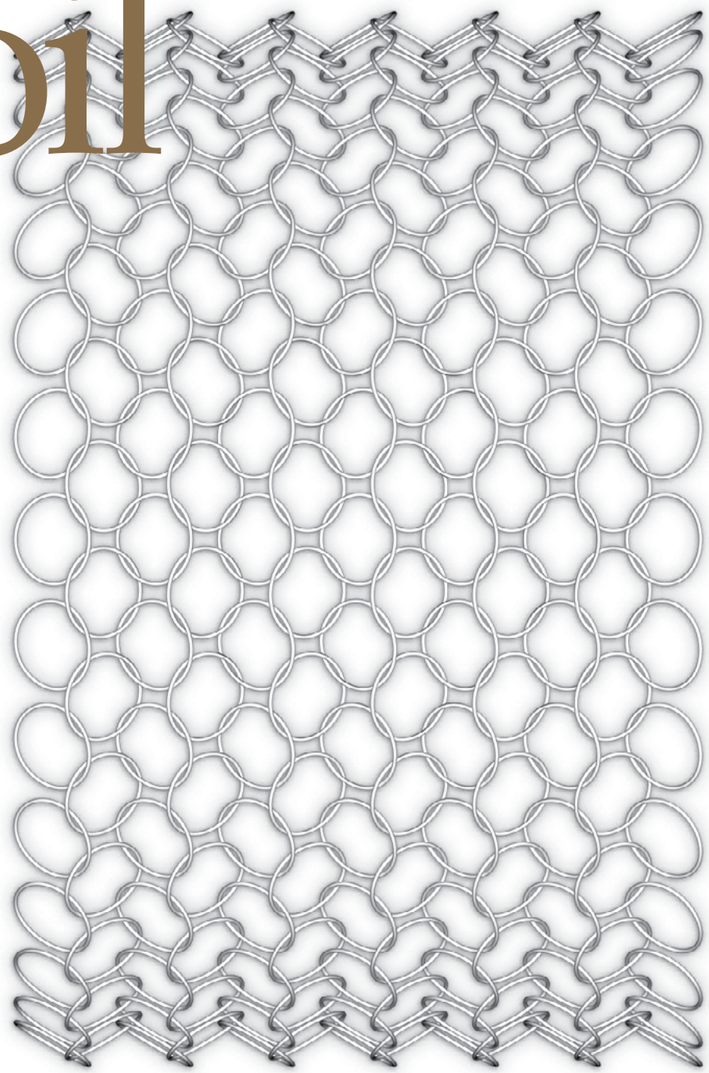
With food insecurity increasing, the call to feed the hungry is as biblical in its urgency and scale as it is in its history. Chef Massimo Bottura is pioneering a new approach of dignity in dining by translating 20 years experience of running fine dining mecca Osteria Francescana into creating inclusive cultural spaces to feed the hungry. Thinking about the food system as part of a broader commons, Nicola Twilley reports on the burgeoning community fridge movement (let us know if you participate in a community fridge!), while Johnny's move to a houseboat inspired the MOLD editor to question our food storage stalwart, the refrigerator, and its efficacy.

The thorny problem of reducing food "waste" is one that seems uniquely built for designers to tackle—it surfaces complexities around culture, materials, usage, functionality, desire and disgust. It also poses one of our greatest opportunities for unlocking the potential of resources currently relegated to the bin, freeing us up to return value to our food system, build more resilient cities and reduce our environmental impact.

LINYEE + JOHNNY

Waste

Love and Soil



HOW MIGHT WE DESIGN FOR CIRCULARITY

TEXT BY LAUREN YARMUTH
ILLUSTRATION BY TIMOTHY LUKE

AS A DESIGNER, I OFTEN FIND INSPIRATION IN STRANGE PLACES—A SEA SHELL; AN EMPTY PARKING LOT; BRICK ARCHES. I WORK WITHIN IDEO'S DESIGN FOR FOOD STUDIO WHERE IT'S COMMON PRACTICE TO USE ANALOGOUS INSPIRATION TO SPARK NEW OUTCOMES AND INNOVATIONS.

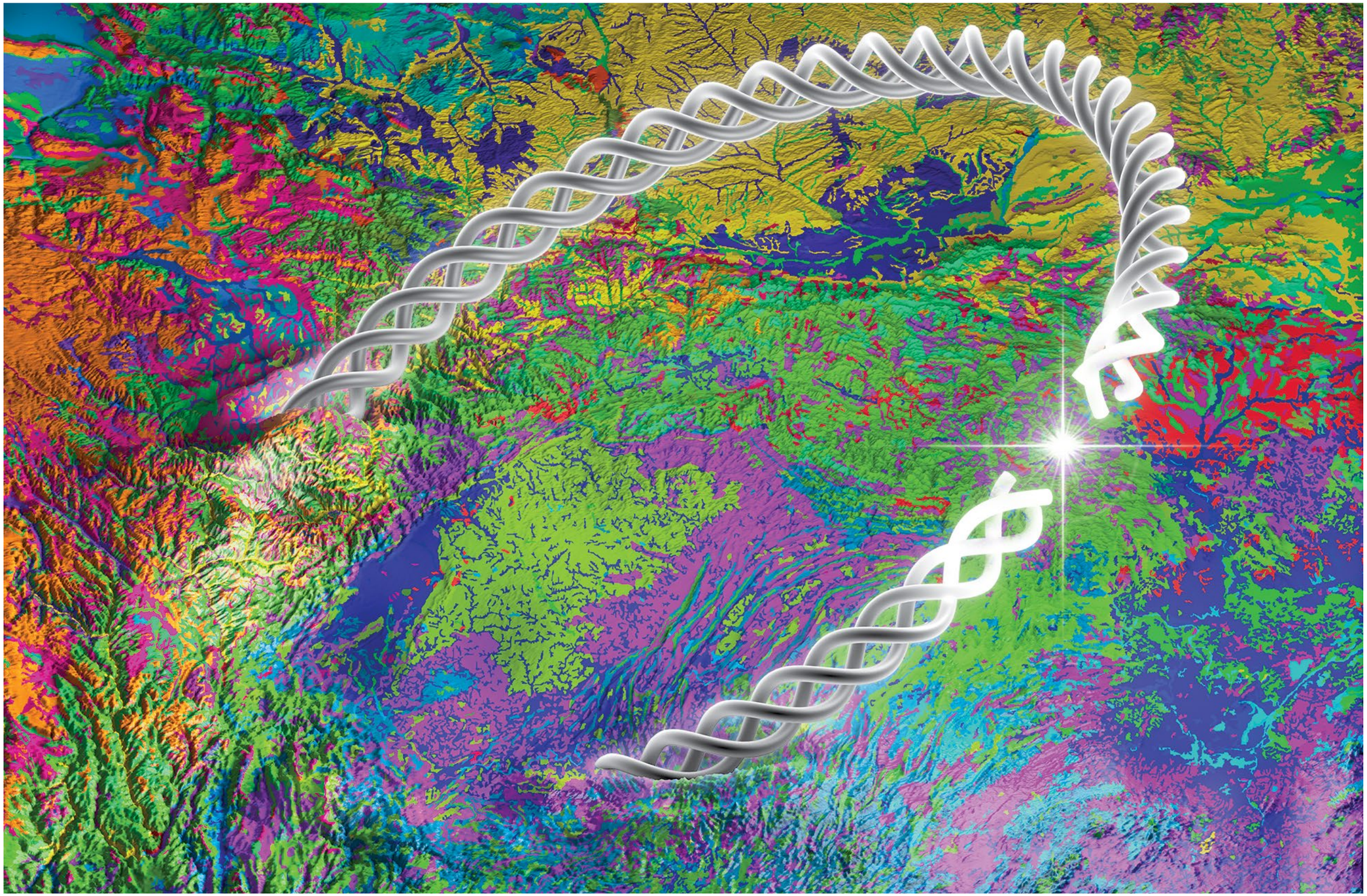
Luckily, I'm not the only one who does this: But I knew I had taken analogous to another level when I told my husband that soil had become my inspiration for our family.

I didn't set out looking for a relationship metaphor. I was actually on a deep dive into the role that design can play in helping us get smarter about the global food system. As I dug, I came to see how soil represents the partnership, interdependence and purpose that can exist when all parts of a system are working together at their best. Soil is the source of so much life on our planet; each component has a role to play, and together those parts have the potential to create abundant goodness for everything in and around it.

Historically speaking, humans used to create and live in systems that, like soil, were closed-loop, circular systems. We made what we needed to survive and thrive, and we reused materials and goods until they were worn through. But somewhere along the way, through technological and engineering innovation, many of us lost our connection with the very things that enable us to thrive. We have come to understand abundance as success without considering the repercussions that this mindset has on our lives and the planet.

To be clear, the advances that have resulted from this shift aren't all bad (many are positive and very impressive), but from a resource perspective, this linear mindset is completely unsustainable. Somehow, at the same time that we are making advancements toward colonizing Mars, democratizing gene editing, quantum computing, and beginning to understand the role of the microbes in health and wellbeing, we have allowed a major blindspot on waste and resources to develop —and worse, seem to have lost sight of our actions having consequences.

According to the United Nations, about a third of the food the world produces every year—1.3 billion tons—is lost during production or tossed by consumers, and North Americans are the worst offenders. The average American



Soil is the source of so much life on our planet; each component has a role to play, and together those parts have the potential to create abundant goodness for everything in and around it.

wastes enough food each month to feed another person for 19 days. Globally, 800 million people are undernourished, and in the United States one in seven people experience food insecurity. Astonishingly, at the same time, nearly one in two adults and one in six children around the world are considered obese. To make matters worse, this devastating spiral of waste, hunger and obesity is haunted by the environmental implications of the same system. Food waste alone accounts for about 21% of fresh water use in the United States, and generates about 8% of global greenhouse gas emissions. To put it another way, if food waste were measured as a country, it would rank third in the world for harmful emissions. And we are paying dearly for it. Globally, food loss and waste costs up to $940 billion per year. Not to mention the fact that by throwing food away rather than managing it as part of a nutrient cycle, we are stripping soil of its integrity to the point that it is becoming harder and harder to grow food in the first place.

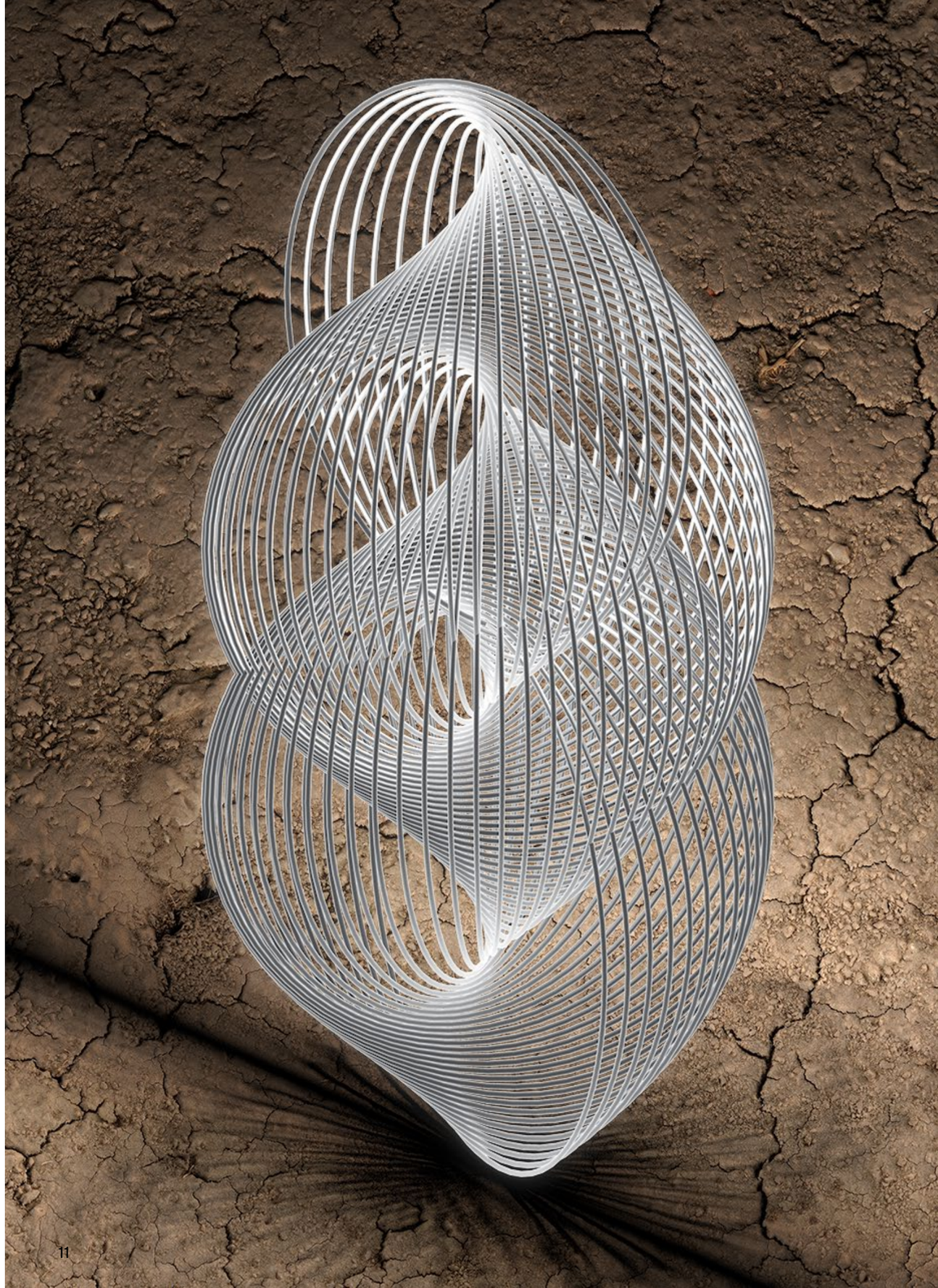
In my work, we often reframe questions and ideas into “how might we”

statements so that we can approach them as opportunities. We use design as an instrument to crack things open and connect with new perspectives so that we can unlock solutions. This was the approach we took last year with The Rockefeller Foundation, as we worked to uncover principles of a future with no food waste in it. How might we:

- Price food to accurately reflect its ecological and nutritional value?
- Measure and manage food as a precious natural resource?
- Ensure that all food gets consumed at the height of its nutritional value?
- Activate our networks to get precisely what we need from food —physically, socially, experientially and psychologically?
- Make it both affordable and convenient to eat fresh food?
- Activate our networks to create value from food we'd otherwise waste?
- Embrace resourcefulness as a fundamental value of our food culture?
- Become insatiable, curious and open minded about food?

These aren't the only questions. They're provocations and calls to action. The system is so complex and the challenge so enormous that we'll need to continue to consider everything from habits and behaviors to industrial systems and packaging, in order to uncover how we might redesign the whole system. Science points to the power of nodal influences, or acupuncture points; you press in just the right spot, and it ripples across the whole system. That's the type of design challenge that we're faced with now: What are the inflection points that we need to press to affect massive changes in our waste behavior on a global level? This is how I arrived at soil.

I am a mother with two little boys. By necessity I move fast, but I also deeply crave slow and meaningful connections. I think a lot about purpose and potential. About what it means to make things whole. For me, soil has become the inspiration for what a supportive ecosystem should be like, a love story I want my kids to learn from and the world to be inspired by. Soil represents a circular system. Many circles in fact. And it's this web of circles that we need to design for so that we see the interconnectivity of it all — food, waste, nutrients, people and systems —and can, eventually, close the loop.



Pathways for Waste

BEYOND FERMENTATION AT NOMA'S R+D LAB

TEXT BY DAVID ZILBER
PHOTOGRAPHY BY MARVIN LEUVREY

TO PARALLEL KEVIN COSTNER'S ACID FLASHBACK-INDUCED FAMOUS MISQUOTE IN *FIELD OF DREAMS*: "IF YOU BUILD IT, THEY WILL COME," WE HAVE TO ASK OURSELVES A QUESTION THAT PERTAINS TO THE BOUNDARIES WE SET IN THE BATTLE AGAINST FOOD WASTE. "IF YOU COOK IT, WILL THEY EAT IT?"

In noma's fermentation lab, ideation often begins in the garbage bin. Somehow, seeing a mountain of black garlic skins, leftover vegetal pulp from blending flavored oils or scraps of beef from cleaning ribs, made the R&D chefs at the restaurant cock their heads sideways just a little further. It's as if only when waste is staring you in the face that your back gets pushed against the wall, and the only way to push back is through creative problem solving. Those scraps all met purposeful and novel afterlives as 'balsamic' vinegar, yellow pea jiang, and garum, respectively. The upside to such situations is the exhilaration you feel at having championed the ever-present elephant in the room, food waste. The downside is that sometimes you end up creating a new problem.

When I talk about fermentation as a powerful tool, a secret weapon that affords a chef or home cook the ability to divert waste streams and transform every gram of food entering a kitchen into something delicious, I mean it. When you look at waste through microbial-colored glasses, that is to say, when you understand the inputs and outputs of fermented food—from shrimp shells and fish guts (which can be autolyzed into delicious fish sauces) to spent grains, or wheat bran (which can be toasted and molded into shoyu)—you stop seeing waste as something useless and beyond hope, and you begin to see ingredients. BUT, there are caveats. Just because you see ingredients all around you, doesn't mean you have a mouth to put them into. Waste and excess aren't necessarily the same things.

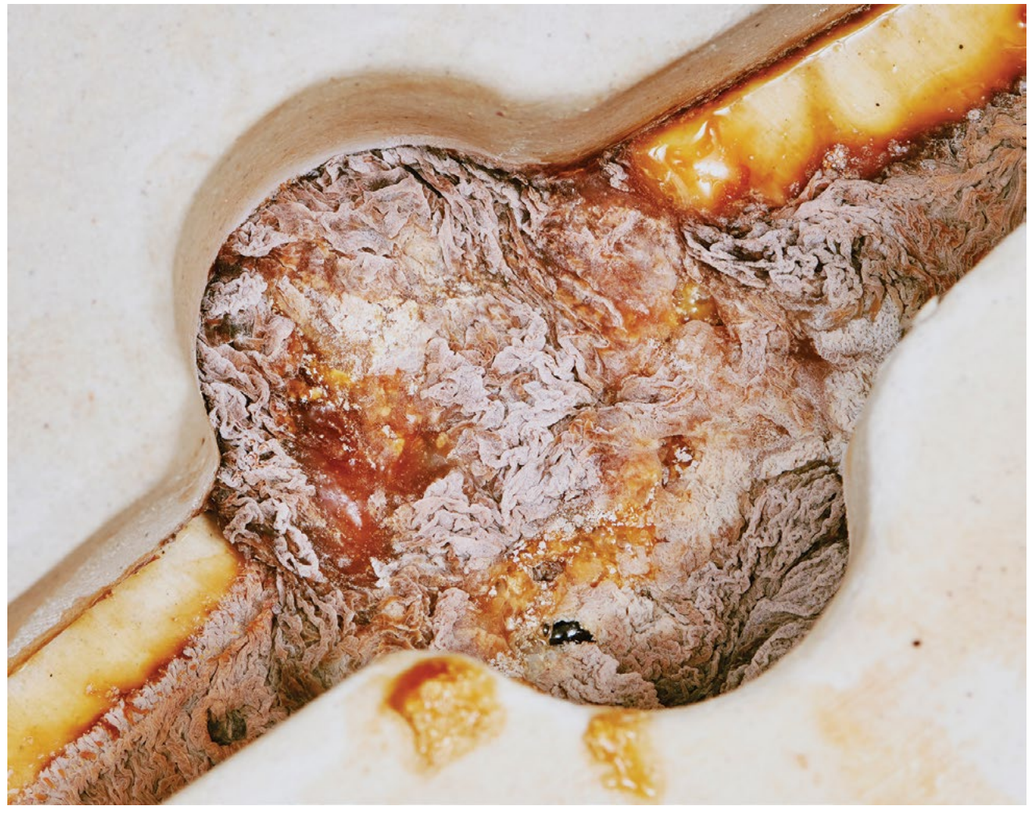
While you can ferment trimmings, peelings, stalks and stems into delicious foodstuffs as an alternative to throwing them out, the resultant ferments don't always have the same consumability as the products you stripped them from. While fermentation is a body of knowledge capable of tackling the problem of what to do with food waste, what it produces are often replete with compounds that, while delicious, can only be eaten sparingly.

Consider yourself a dutiful vegetarian culinarian? Go ahead and cook a whole roasted head of baby cauliflower for dinner, lovingly basted in butter with sprigs of lemon thyme and pineapple sage. When you're full, and stare back at your cutting board in the kitchen and see the ribs, leaves and stalk you trimmed off of your cruciferous feast—and think to yourself "How best could I ferment those trimmings instead of throwing them out?"—briny lacto-fermentation might spring to mind as a viable option. And so, you throw the trimmings into a crock with nothing more than salt, water and whey and let friendly

LEFT Aspergillus oryzae spreading mycelium on dryad's saddle mushroom shoyu.

MIDDLE Lacto-fermented cep mushrooms.

BOTTOM Kahm yeast on peaso (similar to miso but made with peas) tamari.



LEFT Butchering sea cucumbers.

BOTTOM Aspergillus oryzae sporulating on dryad's saddle mushroom shoyu.

microbes digest and transform your food for you, as you sit, watch and wait. But ask yourself this: Could you ever sit down and enjoy a full plate of sour pickles for dinner? Or sauerkraut? Or miso piled as high as risotto?

Or course not. What fermentation rescues from the bin is often held back from being enjoyed as plainly and thoroughly as the fresh foodstuff it was borne of by your need to preserve it. High salt or acid contents may keep malevolent microbes out of the picture, degrading vegetables and meats with intended direction in contrast to the chaotic biome of a backyard composter. Ferments ingested by humans must be enjoyed in moderation for the very same reasons, lest you end up with a severe case of acid reflux or high blood pressure. This postulation isn't intended to dissuade creativity, nor the goodwill required to believe that there must be another way. Understanding the limitations of solutions is sometimes the best way to push creativity even further, in lieu of settling for an imperfect panacea.

At noma, when we harvest mounds of wild rosehip petals at the height of the summer to blend into the most fragrant and potent rose oil you could imagine, we're left with equivalent mounds of rose pulp once the plant matter is separated from the flavored oil. We divert the stream of waste by folding it into miso, blending it into garums, or brewing it into kombucha, giving it a second life in each instance. But even for a restaurant as busy as noma, we'll run out of the intended ingredient (the rose oil) long before we've cooked our way through the miso or garum. But it's only to the credit of the first outlet we conceived of for channeling waste into a useful and delicious medium that we now have the whole flight of floral potions to pepper our menus with.

While we may wish we could use every other application of rose pulp at a 1:1 pace with the oil that makes its way into vinaigrettes and onto langoustines, it just isn't possible. Which means that at times, we have a lot of these ferments around. It's by no means a bad thing, as once these products are shelf stable, they can simply sit and improve. But still we're left to wonder if there isn't still an even better way. Could industries not cross pollinate? With the waste product of one being fed to the consumers of another? (Last year I came across an anecdote about a huge coffee company that would sell its used grounds to a perfume factory, so they could extract any remaining aromas.) The quest for the maximization of profits in big industry all too often leads to egregious waste. But by dedicating time to the creation of value, waste can just as easily be another opportunity to profit.

Humans are adaptable, we're problem solvers by nature. Even (or especially) when the problems are of our own creation, the challenge of facing the possible spurs us on. We employ the best tools at our disposal (be they technological or biological) to dig ourselves out. At noma, we think of fermentation as advantageous a tool as the stoves, or our knives. Ultimately, changing perceptions around what can and should be eaten will be paramount in the battle against waste, but until then; sour, rot, age, bubble and brew your way to a greener and more delicious world.

INTERVIEW BY NATSAI AUDREY CHIEZA
PHOTOGRAPHY COURTESY OF FATBERG

Fatberg

A CONVERSATION BETWEEN NATSAI CHIEZA & MIKE THOMPSON

Like most major capital cities, London, where I live, is a city in flux: under ceaseless and enormous change driven by its always expanding inhabitants. The demands placed on its charming Victorian infrastructure means roads and railways are perpetually under rehabilitation to cope with the sheer volume of activity that keeps the city viable. Nowhere else can that old versus new dichotomy be experienced more viscerally than deep within the city's sewer system. You may have heard of our infamous fatbergs: colossal objects formed from domestic and industrial cooking fat disposed of down drains, which congeals and eventually cause blockages. The Museum of London recently exhibited remnants of the Whitechapel fatberg that went viral when discovered in 2017. Weighing 130 tons and measuring 250

meters long, it was one of the largest fatbergs ever discovered. With a sample removed from its original context and installed in the museum, the so-called "Monster of Whitechapel" helped bring into focus the labor of maintenance performed by engineers who work in these sewers and, more broadly, the politics of disgust.

However, back in 2014, well before the Whitechapel fatberg was discovered, designer artists Mike Thompson and Arne Hendricks commenced work on growing their own fatberg to understand more deeply these curious objects. Their fatberg quickly outgrew its home in a tank and was moved to the open waters of the NDSM shipping wharf in north Amsterdam, where it has taken on a life of its own. I recently visited the site and caught up with Mike to learn how the project has evolved and what they've discovered from their engagement with the materiality of fat.

ABOVE The tools of the trade—melting fat to ready for Fatberg building.

RIGHT Fatberg floating in the waters of north Amsterdam.

Environmental fluctuations demand different sets of tools to manage and build the Fatberg. Here, a pickaxe is deployed to break up ice in the water.

N. CHIEZA COULD YOU SHARE YOUR INSIGHTS INTO "WILD" FATBERGS AND WHAT ENABLES THEM TO ACCUMULATE TONS OF MATTER IN OUR SEWER SYSTEMS?

M. THOMPSON Sewer fatbergs originate from liquid fats washed down into the sewer, which then, slowly, solidify. Their growth is a cumulative process that takes place over a relatively long time during which they can grow to this really, quite profound scale. Thanks to Thames Water, we had the chance to see one ourselves. Between Whitehall and New Scotland Yard, there's a 25-meter stretch at a junction where sewer waste coming from the East End of London meets this particular place, causing fatty build-up to occur. As far as I understand, all it takes to cause a fatberg is some sort of non-human waste, like a plastic bag, to get flushed down and then snag. They refer to it as a reversed glacier —once it solidifies, new fat butts up against it and it starts to grow.

There's this preconception that you're going to see something like the fat you dumped down the sink, whereas it's more akin to looking at soil—the top layer almost smells earthy. When you peel that layer back, you see a thriving ecosystem of worms, flies and moths, all

feasting on this congealed mass of waste. Of course, life doesn't see this as waste. Life just consumes it and reprocesses it back into the ecosystem again. We found it really fascinating that fat, in this instance, starts to take on materiality that's outside of our ideas of what you might expect fat to do. If you put your foot on it, on top of the sewer water like a spongy mattress, it will bob up and down on top of the sewer water. Equally, if you examine chunks of the decomposing bits, it is like limestone.

We're fascinated by how fat becomes a material for production, rather than just a waste material, and seeing how fat accumulates, and then transforms in this setting, becomes quite inspiring.

N.C. HOW DOES THE SUPER-ORGANIC, THRIVING, GEOLOGICAL, MATERIALITY OF WILD FATBERGS CONTRAST WITH YOUR LABORATORY PROTOTYPE? WHERE DOES YOUR FAT COME FROM? WHAT DOES A FATBERG SUPPLY CHAIN LOOK LIKE?

M.T. Our fat comes from a variety of sources including butchers and waste fat donations from people. What we find fascinating is that the different kinds of fat express slightly different materiality. So, for example, beef fat tends to be relatively waxy, pork fat much more buttery, and something like palm oil, or palm fat, much more oily. By combining these characteristics, we end up with a material that's much more practical for what we're trying to achieve.

We render it and purify it into its most basic form. In that sense it differs quite significantly from the fat you see in the sewer. So the wild fatberg is more of a composite material, whereas we're working with something more pure.

N.C. ARE THERE ANY PROCESSES, OR TOOLS THAT YOU'VE HAD TO INVENT TO TRANSFORM THIS MATERIAL AND TO BUILD WITH IT?

M.T. We're building something that no one's really tried to build before, so we've had to create the knowledge as we go.

To create our island, we started with one singular drop. For this, you can start with something as simple as a pipette or syringe. But you quickly end up having to move to much larger tools like squeeze bottles. Now, working with larger volumes of fat, we're having to fabricate tools ourselves, so there's a lot of making tools on the fly, constantly spotting and responding to different behaviors like changes in weather and therefore temperature.

N.C. DO YOU THINK YOUR FATBERG IS LIVING A LIFE SPECIFIC TO ITS ENVIRONMENT? COULD IT BE REPLICATED ELSEWHERE, AND SHOW THE SAME BEHAVIORS?

M. T. I think there'd be similarities but some differences. You've got to remember that the Fatberg started off in a small tank with relatively clean water—which is quite a hermetic context. Even in the lab we noticed very quickly that slime molds move in and start to grow on this thing under water: we even put it under a microscope and looked at what was growing on the fat. It was teaming with microscopic worms and all sorts of other life forms! We then moved it to open water because there was this need to increase the scale. It's now in relatively clean open water, facing directly onto the river IJ in the north of Amsterdam, moving out towards the estuary, but the water is full of all sorts of life. Recently, the slime molds have been thriving and there's evidence of algae starting to grow. There were quite a large number of freshwater mites swarming around it yesterday and even small freshwater shrimp feeding off it. So, the Fatberg has become its own ecosystem—life is very much starting to interact with it and it's a living, thriving thing.

We'd always fantasized that when it got massive, you'd see flocks of seagulls flying around it. Well, now that's literally happening! The minute we walk away from the pontoons where we're working, the seagulls are in there picking up any waste material that's been left around. We've even seen ducks on top of the Fatberg, feeding on it. So, they've very much taken it as part of their ecosystem. You could argue if you move it and put it into another location, then the kind of micro-fauna that would start to frequent it would potentially be quite different.

Now that nature's interacting with this as well, we're finding that the remnants of slime molds and bacteria are all being trapped inside. Fat has an almost time capsule-like property: there's a reason people use oils to create perfumes; fats are able to trap certain odors. You can almost say that every drop we add, every layer that gets created, is trapping a moment in time within it.

N.C. WHAT KIND OF CONSTRAINTS HAVE YOU FACED AS YOU'VE TRAVERSED SCALES, FROM THE ENCAPSULATED, SEMI-STERILE ENVIRONMENT OF THE TANK TO OUT IN THE WATER?

M.T. As far as we're concerned, we are agents for fat. Fat is telling us we have to accumulate fat, build this island, and it has to be as big as possible. It's about confronting everybody with this material by giving it an autonomous presence.

We're already at 1.2 tons. We're at a point with the scale where another 60 kilos is being added today— quite a large quantity of material. But, that doesn't look like an awful lot anymore. We calculated that five tons would mean that the Fatberg has a diameter of about two meters.

The challenge we face—because 90% of it is under water at any one moment—is that it's probably going to touch the bottom of the basin its in, and so it's going to need moving. So, there's a challenge of location, and getting hold of the kinds of volumes of fat that we need—no longer domestic quantities but not quite industrial, yet. So there are all sort of logistical challenges just to do the work.

N.C. AND THESE BECOME A PART OF THE DESIGN PROCESS OF MAKING.

M.T. Yes, absolutely, this project is really about storytelling and story making. All of these challenges are part of that story. It becomes a way to talk about how we're engaging with this material in ways that we currently don't. We can confidently say that we're the most skilled fatberg builders on the planet. It's about how you bring these very disconnected themes and topics that relate to fat in dialogue with one another in order to understand it from a different perspective.

N.C. WHAT ARE SOME OF THE UNEXPECTED NARRATIVES, MYTHOLOGIES, PRACTICES, THAT YOU'VE ENCOUNTERED IN FAT MAKING?

M.T. It's more to do with where we're doing it. The NDSM wharf has been reformed into a cultural area, but it's steeped in shipping history. We're at the bottom of this ramp where they used to launch huge ships into the water. We discovered they used to use whale oil as a runner to slide the boats down it into the water. So there's a history of whale blubber being used as part of the ship building process. Fat is just a regular material. In some respects, the Fatberg is still part of that process.

Lately, I've been considering the cultural aspects of fat and how people relate to it. The immediate response is to find it disgusting. But, I think that is a sign that people are intrigued by something they wouldn't come across every day. People will immediately start discussing the Fatberg in a way that gets past the tried, tested and quite limited lexicon we tend to have for this material.

N.C. THAT'S IT. IT'S THAT THING OUT OF PLACE, NOT KNOWING HOW TO CONTEX-TUALIZE IT. INSTINCTIVELY, THERE'S AN APPREHENSION BUT, BY UNDERSTANDING IT, IT CAN ALL FALL AWAY.

M.T. Yeah. I think the Fatberg throws the idea of "what is clean" up in the air. The notion of cleanliness is something that we, as humans, have developed over a period of time towards fat and our relationship with bacteria. But because our Fatberg has become part of this ecosystem and now that we're around it all the time, we have a totally different relationship with it.

Dripping increasingly larger quantities of fat from increasingly larger fabricated tools, the Fatberg island continues to grow.

It is often said that a weed is a plant out of place. The Fatberg challenges our perceptions of waste by re-contexualizing it in a new place and asking what new relationships can we begin to catalyze? This whole systems approach to production and consumption is circular in nature. New perspectives could offer opportunities for food waste to help feed a city, or make the food system more biodiverse.

TEXT BY MAX ELDER
ILLUSTRATIONS BY MIYU SHIROTSUKA

Designing for Systems, Not Symptoms

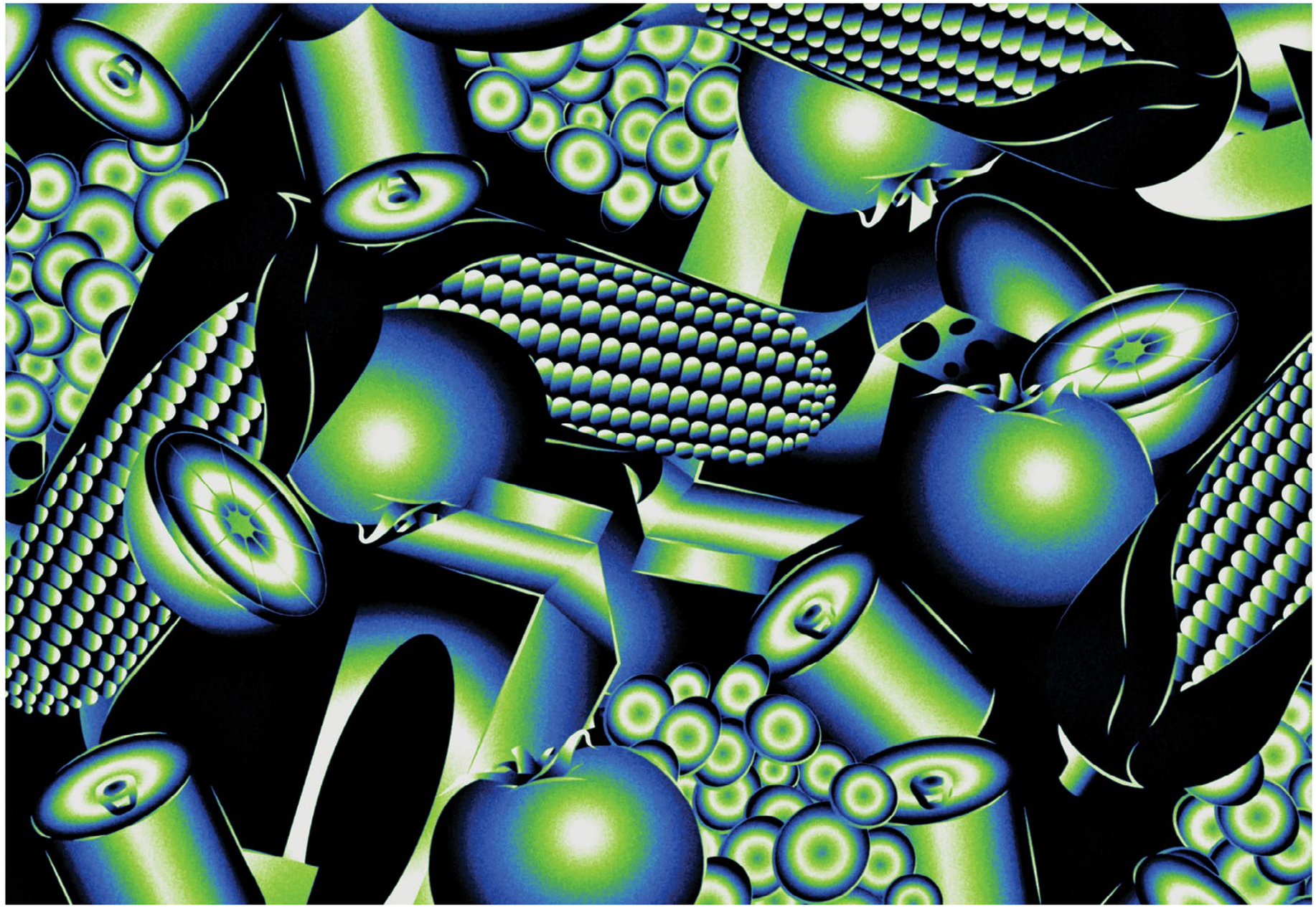
ONE FUTURIST'S FOOD WASTE MANIFESTO

IF EFFICIENCY IS A HALLMARK OF GOOD DESIGN, THEN THE GLOBAL FOOD SYSTEM IS A FAILURE. AS MUCH AS ONE THIRD OF ALL FOOD PRODUCED FOR HUMAN CONSUMPTION IS WASTED EVERY YEAR.

THAT WASTE PILES UP IN OUR LANDFILLS, CONTRIBUTES TO CLIMATE CHANGE AND OTHER ENVIRONMENTAL ISSUES, AND REPRESENTS BILLIONS OF ANIMALS WHO WERE KILLED FOR NO REASON.

WHILE THE ISSUE OF FOOD WASTE HAS INCREASINGLY BEEN IN THE SPOTLIGHT, MOST OF THE DISCOURSE IS TOO NARROW, SQUANDERING OPPORTUNITIES TO THINK BOLDLY AND BROADLY ABOUT SOLUTIONS.

THIS MANIFESTO IS A CALL FOR DESIGNERS TO USE THE SHARPEST TOOL IN THEIR TOOLKIT—THE ABILITY TO FRAME AND REFRAME ISSUES FROM MULTIPLE PERSPECTIVES—TO IMAGINE AND DESIGN ROBUST SOLUTIONS FOR THE SPECIFIC PROBLEMS PLAGUING OUR FOOD SYSTEM. HERE ARE FOUR NEW WAYS OF LOOKING AT THIS OLD CHALLENGE OF FOOD WASTE.



1 THERE IS NOT ONE SINGLE PROBLEM

Waste is the hydra of problems in our food system—it has many vicious heads. One in nine people goes to bed hungry every night around the globe, meaning that wasted food could otherwise feed starving stomachs. If food loss and waste were a country, it would be the third largest greenhouse gas emitter. Food waste affects not only people and the planet, but also animals. About 20% of meat and 35% of all fish and seafood is wasted globally. Since over 56 billion terrestrial farmed animals—and an estimated one trillion aquatic animals—are slaughtered every year for human consumption, this unused meat equates to billions of animal lives.

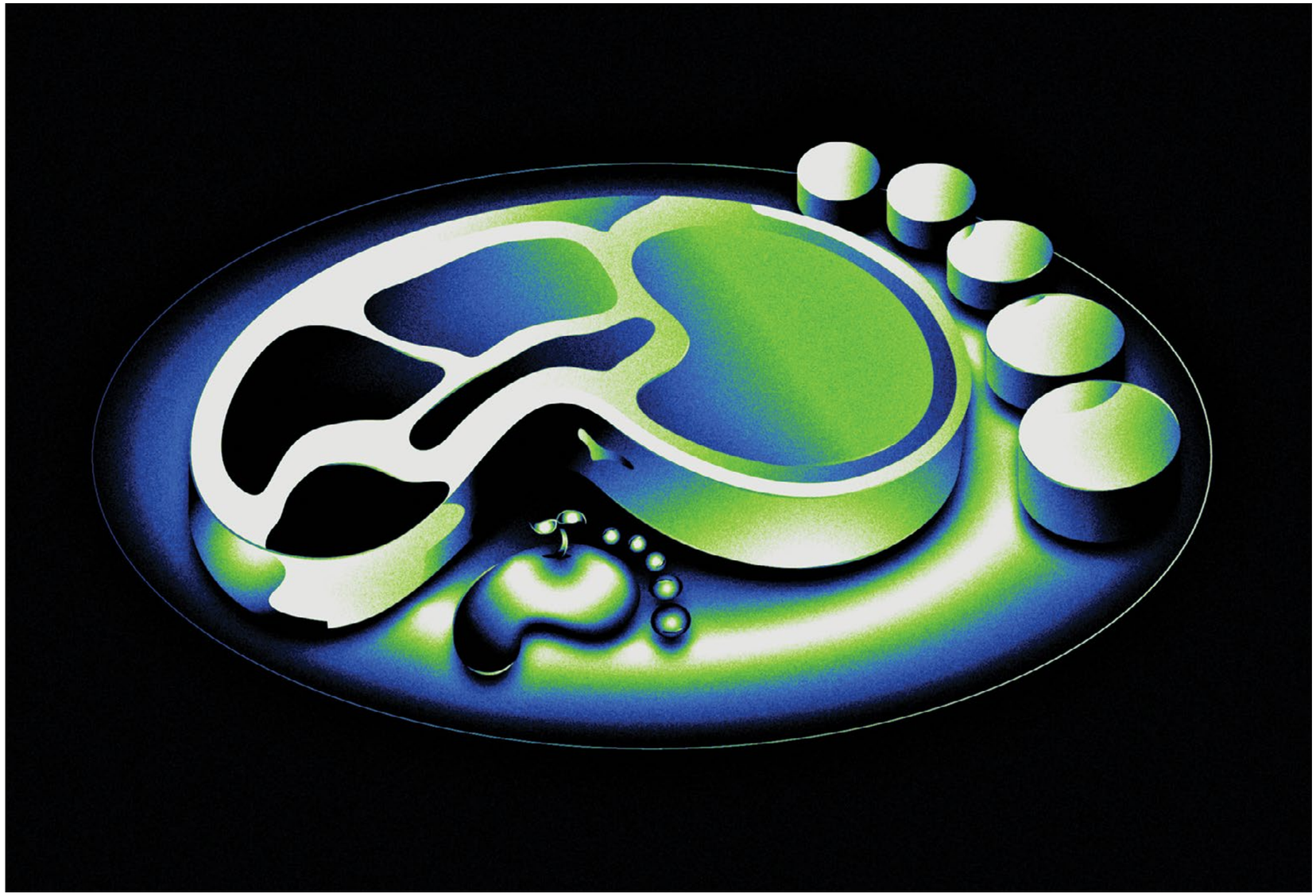
Everyone can approach this monster from a different angle, be it feeding the hungry, curbing greenhouse gas emissions, or creating a more humane food system. We can't make progress without defining the problem, and we can't define the problem without knowing our goals.

2 WASTE IS A RESOURCE

It turns out that waste doesn't need to be wasteful. Sometimes repurposing, or upcycling, food waste is more realistic than trying to eliminate it. Minimizing waste is always a worthy goal, but some level of waste seems inherent to our food system. When we see waste as just a problem, we limit our thinking and approach to solving it.

At Saltwater Brewery in Delray Beach, Florida, brewers are turning spent barley and hops into eco-friendly six-pack holders. These rings are entirely biodegradable and edible, keeping oceans plastic-free and turning death traps into delectable treats for aquatic animals. The beer brewing industry is not the only one that sees waste as a resource; researchers in the organic food world have been developing innovative methods to convert food waste into a biofuel.

Researchers have recently coupled hydrothermal liquefaction and anaerobic digestion to convert food waste into biofuels. "Food waste should have a high value," says Roy Posmanik, a Cornell researcher working on these efforts. "We're treating it as a resource, and we're making marketable products out of it."



3 WHAT WE WASTE MATTERS MORE THAN HOW MUCH

Food waste is measured in tons, not types. But not all food waste is created equal, since different foods have different impacts on our environment, our bodies and our farmed animals. Some foods we produce are more environmentally harmful, some are more nutritious, and some are more humane. The simplest heuristic for determining the worst waste is whether it's animal-based or plant-based. Animal-based waste is more resource intensive, linked to more negative health impacts, and more harmful for farmed animals.

Even the same kind of food can have a dramatically different impact depending on its lifecycle. Plantagon CityFarm, which produces lettuce, has built vertical farms in the basement of office buildings in Stockholm, re-routing the heat that their LED lights produce to warm the building during the winter months. Vertical farming systems can use up to 95% less water, and produce almost 400 times higher annual yields, than their soil-based counterparts. Redirecting the heat byproduct lowers costs and energy usage as well. A wasted pound of Plantagon lettuce is not the same as a wasted pound of traditional lettuce because Plantagon's production methods are much more sustainable.

4 UNDERSTAND TIDES, NOT WAVES.

The food waste discourse focuses too much on the surface, without diving deep into the real causes. We've been too distracted by the waves in order to fully appreciate the tides. One example is the ugly produce movement, in which well-meaninged activists and entrepreneurs, like Imperfect Produce, are "changing the world" by selling boxes of fruits and vegetables that don't meet cosmetic standards to be sold in grocery stores.

But according to the Natural Resources Council, only 12% of fruit and vegetable waste occurs during distribution and retail. Much more fruit and vegetable loss is caused by consumers at home and restaurants, and during production, post-harvest, handling, storage, processing and packing. The 12% of losses during

distribution and retail are not just because the food is ugly, but also because the food is damaged, expired or due to other quality control issues. Buying ugly produce tackles less than a tenth of the problem of produce waste. Even less, since a majority of food is wasted at the consumer-level, you can still buy ugly produce and then waste it. While a worthwhile endeavor, this Instagram-fabulous and VC-backed trend of consuming ugly produce is a misallocation of limited resources. Consider also that animal-based waste is much more resource-intensive than plant-based waste, so saving those ugly fruits and vegetables ought to be a lower priority.

DESIGNING SOLUTIONS FOR THE FUTURE

Designers are trained to understand and address systems, not symptoms. That makes them uniquely positioned to use these four approaches to create meaningful solutions to the pernicious problem of food waste. The design of our food system —from its structure to its energy flows and its distribution networks—is rife with inefficiencies. Designers have the ability, and the mandate, to re-frame the problem of food waste in more creative and constructive ways. If they don't, we may waste our chance at creating a more sustainable and humane future of food.

THE ART OF EATING WELL

TEXT BY
MASSIMO BOTTURA

IMAGES COURTESY OF
FOOD FOR SOUL

ON THE POWER OF THE MEAL

I am an Italian chef. The most valuable lessons of the Italian kitchen are to make the most of nothing and to never throw anything away. No crumbs or bones ever get thrown in the bin.

LEFT
Chef Massimo Bottura cooking at Refettorio Gastromotiva in Rio de Janeiro, Brazil, 2016.

RIGHT
A chef prepares dessert for dinner service at Gastromotiva. Photos of Gastromotiva by Angelo Dal Bo.

BELOW
Black and white frescos by local artists Luca Zamoc and Luca Lattuga decorate the walls of the Social Tables Ghirlandina in Modena, Italy.

A ragù is nothing other than a sauce made with scraps of meat, fish or vegetables. In his *Science in the Kitchen and the Art of Eating Well*, Pellegrino Artusi collected recipes from all over Italy—North to South, islands included. We often say that, while Garibaldi was unifying Italy on the battlefield, Artusi was doing so in the kitchens. The recurrence of some ingredients is mesmerizing. Just think about bread. There are recipes for breadcrumb soups, loaves, meatballs, flans made with bread, not to mention the pasta-like passatelli. Even my favorite dinner meal, as a kid, was "milk soup." You might wonder, so where's the bread in that? Well, it was served with huge chunks of stale bread that I would dunk in a bowl of warm milk with a sip of coffee left from the moka machine added, and lots of sugar. I mean, loads. Delicious. Just like bread, meat can be re-cooked and re-purposed in many ways: meat used to make broth is then re-used in hundreds of other ways: meatloaves, meatballs or as stuffing for fresh pasta. And then there's vegetables, cheese rinds and bones. What all these ingredients have in common is that they're often considered leftovers. Bread becomes stale; meat has lost some of its succulent juices and flavor. But eventually, they are still used to make something nutritious and tasty.

Sylvie Fleurie is a contemporary artist who expresses her critical view of society through common objects made out of uncommon materials. I bought one of these objects—a gold-plated waste bin. When I unpacked the 40 cm-high bin, it seemed to glow from within, warm and radiant like the sun.

It is said of some people that they are "beautiful inside." A browned banana, a bruised fruit, a chunk of stale bread—these ingredients still have huge potential in terms of smells, flavors and texture. The responsibility of the chef—as well as that of all of us cooking at home—is to find the inner beauty of each product and to make the most out of it in each phase of its lifespan. Straight out of the oven, a loaf of bread is ready to be served at the table and eaten as it is, still warm and fragrant, without even waiting for the crust to stop crackling. The day after, it might be sliced and toasted to make bruschetta. A day more and it is perfect to be chopped and seasoned with tomatoes to make panzanella, or to make pappa al pomodoro. On the fourth day, it can be turned into breadcrumbs for passatelli or for exquisite gratins. In this way, leftovers are reintroduced into the food chain—with extra value. In the end, the point is to return dignity:

To an overripe tomato that is not in perfect condition but is still perfectly edible.
To an abandoned space in the suburbs.
To a person in vulnerable conditions, who is socially marginalized.

LEFT
At Refettorio Gastromotiva, Brazilian artist Vik Muniz's chocolate painting of the "Last Supper" hangs on the wall.

In West London, Food for Soul collaborated with designer Ilse Crawford to create a warm dining room for Refettorio Felix at St Cuthbert's centre. Photo by Simon Owen/Red Photographic.

ABOVE
In 2016, chef Alex Atala cooked a meal using surplus ingredients donated by the catering companies that supplied the Olympic villages. Photos by Angelo Dal Bo.

Looking at what is neglected, discarded or ignored is at the core of the mission of Food for Soul, the non-profit organization that my wife Lara and I founded in 2016. We build community kitchens around the world with the help of different people, associations and institutions. First, artists, architects and designers transform disused spaces into beautiful and inspiring hubs, complete with fratino tables—tables for 8 to 12 guests, where no one sits at the head. All equals. Chefs transform surplus ingredients into three-course meals. A team of volunteers serve those dishes directly at the table to people living in socially vulnerable conditions.

We started from a very simple —though, now that I look back, I'd say crazy— idea: to apply everything that we had learned in more than 20 years of experience at Osteria Francescana to a brand-new model, completely unexplored and unknown to us. We distilled our experience into three tenets: quality of ideas, the power of beauty, and the value of hospitality, to a community kitchen. Now we have six projects around the world: the first seed was in Milan, then came Bologna, Rio de Janeiro, Modena, London, and most recently, Paris. On March 15th, we opened Refettorio Paris in a place with great historical value: the crypt of the church of La Madeleine.

Any time that I visit one of these places, I ask myself, "how powerful can a meal be?" I mean, sitting around the same table, immersed in a space of art, design and beauty; sharing a meal, a good one; creating and stimulating human exchange. All this happens in front of a simple soup—made with ingredients otherwise wasted. Indeed, how powerful a meal can be.

This is why I always say—and I'll keep repeating until I'm heard—that Food for Soul is not a charity project, but a cultural one. We are not aiming to serve as many meals as possible, and consequently feed as many people as possible. We aim to change the mindset. We want people to look at food, spaces and other people with different eyes —

understanding the potential of anything and anyone. We want to make visible the invisible.

When we decided to open the first community kitchen in Milan, Refettorio Ambrosiano, I found myself calling all my chef friends, one by one, asking them to fly over to Italy to cook for 100 people per night. "But please," I told them, "don't bring your recipes with you. They'll be useless." Nevertheless, some of them brought their recipes anyway. The moment our food truck arrived and our team unloaded boxes of surplus cauliflower, zucchini, basil, strawberries and cheese, they would finally understand my unusual request. I could tell by the look of shock on their faces.

We collected the resulting new recipes, made out of necessity, in a book. In November 2017, we released *Bread is Gold*. The title came from a recipe that we used to make at Osteria Francescana—a dessert made only with breadcrumbs, milk and sugar, like the beloved milk soup of my childhood memories. If you're only looking for a book for recipes, you might be quite disappointed. Like Artusi, you'll find recipes for meatballs, loaves, soups and ice cream—eventually, we had to deal with tons of stale bread, rivers of milk, mountains of cheese rinds and overripe fruit. I like to say that *Bread is Gold* —again, like Artusi's— is a book of ideas that will help you be resourceful with ingredients, no matter how fancy they are or how nice they look.

Food waste is one of the biggest problems of our century. Numbers are numbers. Almost one billion people are undernourished. One-third of the food we produce globally is wasted every year, including nearly four trillion apples. Just imagine how many apple pies we could make! I am an optimist and I believe that we are already making positive change, and pushing people through it with all our strength. Because, guess what: everyone can participate. Everyone can make a difference by simply cooking and sharing the most powerful tool for change: a meal.

A RECIPE, AFTER ALL, IS A SOLUTION TO A PROBLEM.

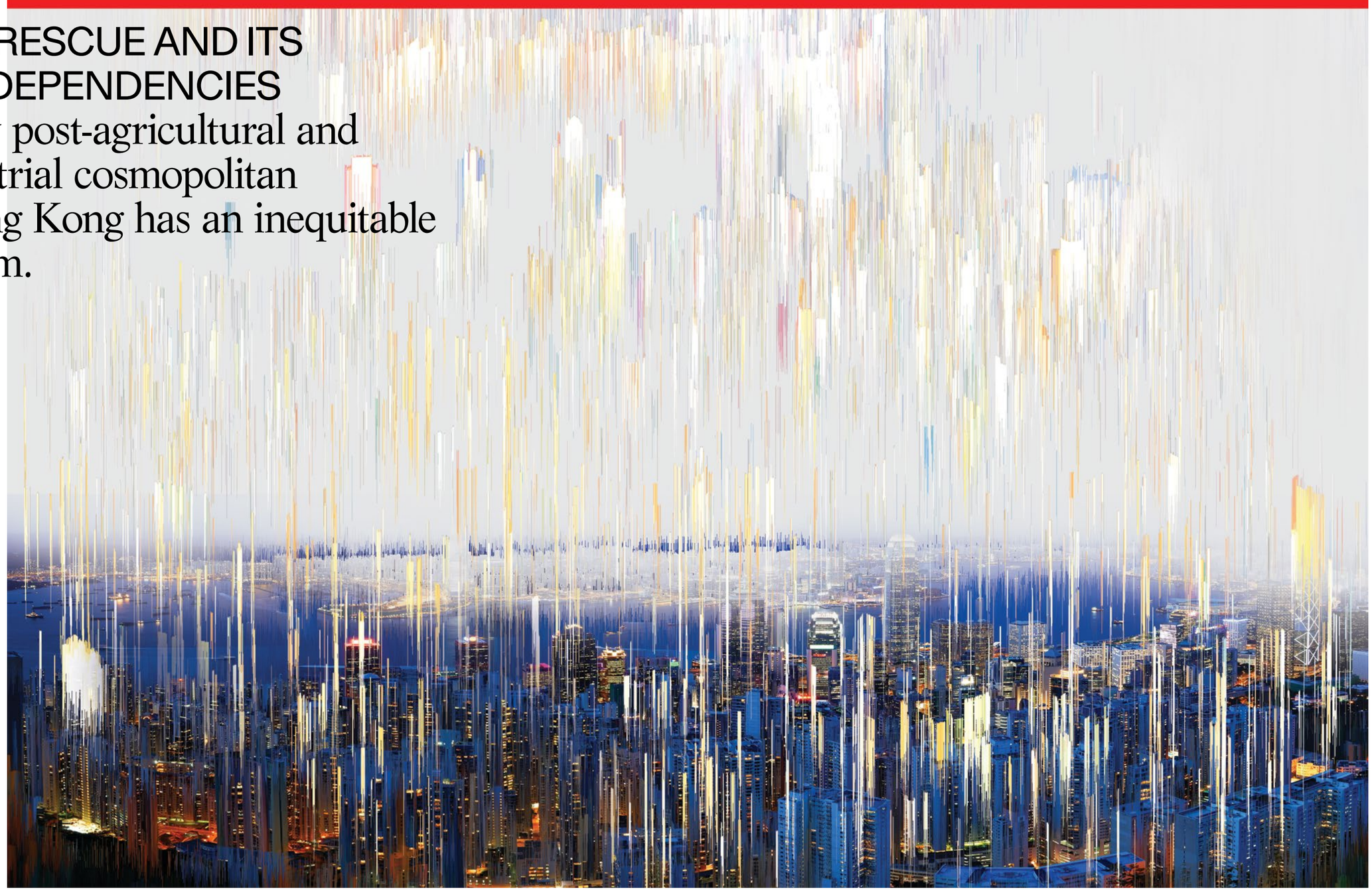
PARASITIC ETHICS OF FOOD WASTE

TEXT BY
DAISY TAM

ILLUSTRATIONS BY
ERIC HU

FOOD RESCUE AND ITS INTERDEPENDENCIES

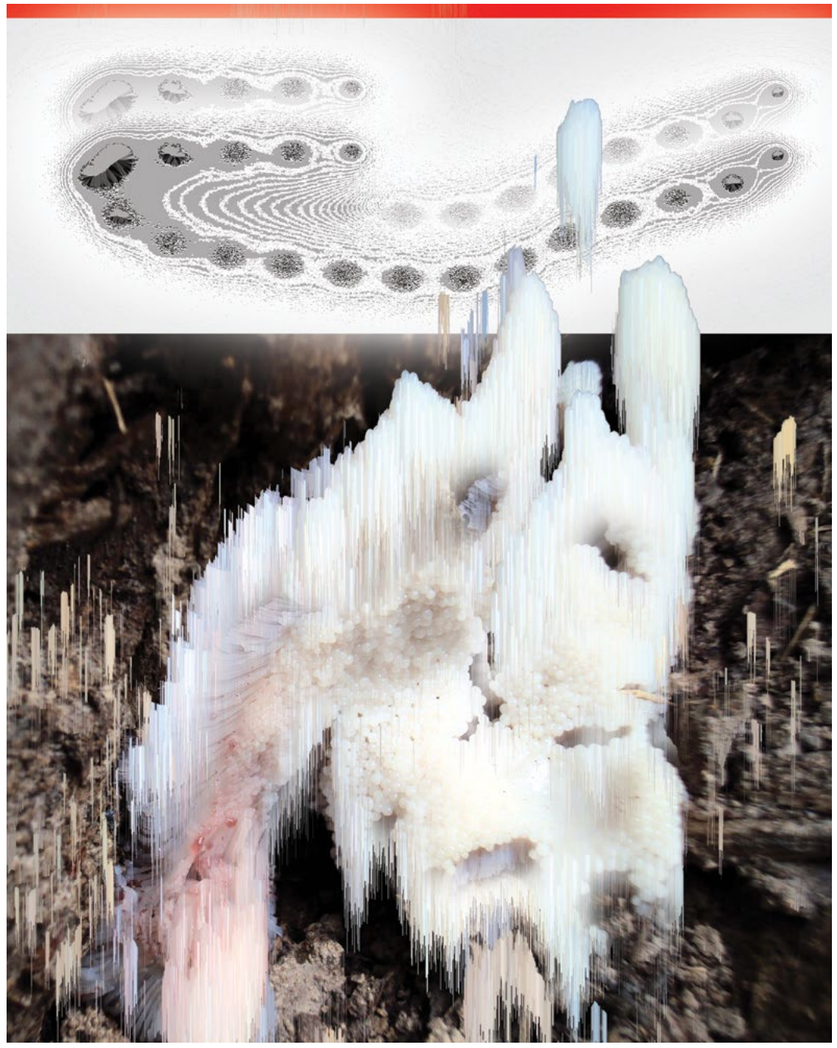
Like many post-agricultural and post-industrial cosmopolitan cities, Hong Kong has an inequitable food system.



The city imports over 90% of the food it consumes and disposes 3,600 tons of it a day into landfills, enough to feed 6 million families. Meanwhile 20% of its population face food insecurity. Thus, reducing food waste has been identified as the keystone of sustainable urban development in Hong Kong. However, although the government has been pouring resources into campaigns against waste since 2013, their message of "waste not, want not" is inadequate. Indeed, a seemingly mundane task turned into a vivid illustration of the deeper problem with this message and started me on my journey of thinking about how to rescue food waste.

It was just past midnight when I took the last pot of yogurt from the shelf of one of the city's many 24-hour grocery stores. With a scan of the barcode, the cashier realized that the yogurt's expiry date had passed and they could no longer sell it to me. Instead, I offered to take the yogurt for free to relieve the supermarket of any liability should I have suffered food poisoning. But that too, I was told, was not possible. Instead, it had to be taken to the super-market manager, who would log the pot and return it to the manufacturer to be disposed of, undoubtedly into a landfill after yet another journey.

My yogurt mission demonstrated that the structural and systemic causes of waste in our food system is not a problem that can be solved individually by having good attitudes of "waste not, want not." Waste, in



and of itself, is not an inherent category, rather, it is the by-product of a system in which it has no place. The British anthropologist Mary Douglas in her seminal work on dirt famously claimed that, “there is no such thing as absolute dirt.” She went on to explain that, “no single item is dirty apart from a particular system of organization in which it does not fit.” Shifting the discussion away from the individual item, Douglas points our attention instead to the structuring capacities of culture.

Classification systems of expiration dates and best-before dates, institutional disposal guidelines and waste management procedures, all condemned that pot of yogurt into the waste chain. Waste, in this scenario, was incurred not because the product was not wanted but because of a linear, closed, proprietary chain. So the

LEFT Cathayacanthus spinitruncatus Amin, Heckmann & Ha, 2014 from Leiognathus equulus.

TOP Unidentified Amoebozoa, southern Moravia. Image courtesy dendrofil.

BOTTOM Unidentified Amoebozoa. Image courtesy dendrofil. Photos via Wikimedia.

question becomes, how should we design a system to maximise the circulation of food to delay obsolescence and accommodate surpluses?

This was the question that initially drove me to my work in food rescue. While doing my PhD in London, I worked for many years in Borough Market, selling apples for a local farmer. On Saturday nights when the shops closed, we would exchange leftovers amongst ourselves or pass them on to those in need of food. There was always a place where excesses could be utilized and these practices became the norm for me. From the market to the city, I have since continued to ask the question, what can we do to stop food from becoming waste?

We do not eat alone, as we are all inextricably linked and enmeshed in networks of interdependencies and support. Acknowledging this is the first step to building a more ethical, sustainable food system. The parasite is a trope which I often use to think through these relationships. Often regarded as a purely negative figure, from biology to socio-political metaphors, the parasite is perceived as a free-rider who takes without giving back. But the French philosopher Michel Serres highlights the original meaning of the word, *para/sitos*: the being that eats alongside. In our urban food system, the interdependencies of urban/ rural, distributors/ producers, retailers/consumers, NGOs/government are inextricable—we all feed off the labor of others. No one can really say who is taking from whom, and all are parasitic upon all. For me, building an ethical food system requires a system where these relations are acknowledged and accommodated, such that no one, or nothing, is out of place.

Food rescue is a form of organized food redistribution that taps into this concept. Normally undertaken by charities, food surpluses are collected from a range of venues, including markets, restaurants, hotels and catered events, and redistributed to local community groups serving a population in need. This has been considered a win-win strategy for all stakeholders as it reduces food waste at the source, increases food security for the vulnerable and reduces stress from landfills.

However, while discourses of goodwill to care for the poor and the environment capture public attention, the idea of "gifting" as a way to help those perceived to be unable to help themselves often discounts the dignity and preferences of individuals. It also reduces the drive to acknowledge conditions of unequal access and the creation of different modes and hierarchies of care. Further, this framing limits the imaginations of what the sector could potentially achieve—food rescue organizations are not just "good Samaritans," they improve wasteful proprietary food chains by creatively channeling resources to those who can usefully absorb surpluses.

In the drive to reduce food waste, we need a more ecological approach to understanding our food system. Food rescue enables us to see how resources could be channeled differently, but as an administrator of a local food rescue organization bluntly put it, "the poor might not need the surpluses as much as we need them to help us consume the excess." Indeed, the questions that come with the "gifting" paradigm shift with a change of perspective—as we continue to rely on charities to pick up the pieces of our unsustainable food practices, we need to see that food waste is everyone's problem.

FEEDING AMERICA

TEXT BY MAURA SHEA

PHOTOGRAPHY
BY THOMAS MCCARTY

NOURISHING THE BODY & SOUL

Consider this as you walk down a supermarket aisle: one in eight people in the United States do not have enough to eat.

Volunteers pre-package surplus squash at City Harvest Food Rescue Facility in Long Island City, Queens.

There are people facing hunger in every community—your neighbor, co-worker and the woman next to you on your morning commute. He is the child next to your son or daughter at recess or in school.

For 38 years, Feeding America, the United States' largest hunger-relief organization, has been leading the charge to rescue food and get it to families who need it. In the last year alone, we rescued 3.3 billion pounds of food from going to waste (that's more than 7,500 jumbo jets) and provided it to hungry families through our nationwide network of 200 food banks and 60,000 food pantries and meal programs.

The question remains, however, how can we do more? The reality of our economy today means food insecurity and hunger is persistent across the country. Last year in the United States, more than 41 million people had the experience of not knowing where their next meal would come from. Add the growing health crisis we're seeing, and eating a nutritious meal becomes even more urgent.

This year, in partnership with The Rockefeller Foundation, Feeding America explored ways to increase peoples' access to fresh, nourishing produce by innovating our charitable food distribution models. But moving from the traditional food banking

City Harvest rescues and delivers 160,000 pounds of food each day with a fleet of 22 refrigerated trucks deployed from their 45,000 sqare foot facility.

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model of boxed pastas and canned vegetables to having perishable foods available to people more reliably requires a shift in the capacity of our food banks and our food pantries.

Because fresh fruits and vegetables are perishable, food banks, food pantries and meal programs face challenges in managing the costs of distributing produce quickly and often over long distances. Through research and concept development with a food bank in our network, Feeding America's innovation team uncovered two key findings. Limited availability and inconsistency made it difficult for food pantries to predict what produce is available and when. This not only makes it challenging for food pantry volunteers to plan for storage and distribution, but also results in pantry patrons having a low expectation of getting fresh fruits and vegetables from their food pantries. Secondly, as with any busy family, we found that knowing how to plan and prepare healthy and satisfying meals using fresh produce is a challenge.

With these insights, we developed and tested two concepts for making fresh produce more accessible—both in food pantries and at home. In our first concept, called Side Car, pantries order the quantity and kind of produce their patrons request and have it delivered just in time for their scheduled food distribution. This service eliminates the need for storage by immediately repacking produce into display crates and delivering them directly to pantries using optimized distribution routes. By serving pantries as nodes within a coordinated network using trucks on an optimized route, we connected pantries with a service they hadn't been able to achieve

This year, City Harvest will collect 59 million pounds of food from farms, restaurants, grocers and manufacturers to help feed nearly 1.3 million New Yorkers.

as independent units. This service is an innovation of our network structure, product and customer experience.

The second concept, Now & Later, mobilizes local chefs to prepare family-style meals at program sites using only fruits and vegetables from our local produce cooperatives. Families were invited to enjoy a delicious meal made from local chefs using regional produce, in a welcoming and hospitable environment. At the end of these dinners, families were given the recipes, prep tips and ingredients needed to cook the same meal at home. Programs like Now & Later are not only social experiences in hospitable and inclusive environments, but they provide an opportunity for people to understand food and its nourishing potential for themselves and their family.

Now that we're able to manage more diverse donated products including perishable foods, we're starting to consider the user experience. What does that actually look like at the touch point of the end user? What are our users' preferences? It's not one-size-fits-all: we have cultural preferences; we have dietary requirements; we have time and access points that we need to think about differently.

We must also continue learning how much fresh produce availability impacts our charitable food network and people facing hunger. We are exploring further questions including: How much of these fruits and vegetables are wasted once they reach food pantries or people's kitchens? Will these efforts affect the health of people facing hunger or increase their consumption of produce? How might we create health partnerships and alternative access points?

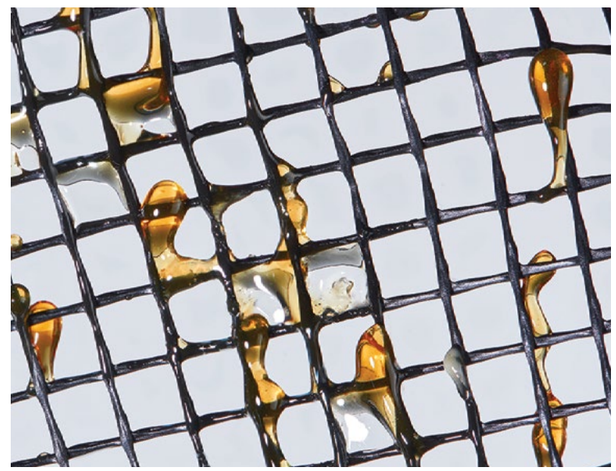
As we think about transforming the charitable food model and our organization to be more user centered, we need to measure impact beyond pounds of food recovered. Instead of measuring truck loads, a new metric might consider the right variety, quality and quantity of foods. That's not about pounds, that's about making sure that people have access to a mix of food that is high quality and nourishing, both to the body and soul.

SPECIAL THANKS TO
CITY HARVEST AND
THE STAFF OF THE FOOD
RESCUE FACILITY.

MATE— RIAL FUTURES

TEXT BY
MARTA GIRALT DUNJO

PHOTOGRAPHY
BY JUSTINAS VILUTIS



MINING FOOD WASTE IN THE ANTHROPOCENE

The ubiquity of food waste has sparked the interest of designers and industries around the globe who see its potential as a new (and abundant) raw material.

One burgeoning area of interest in design is the use of the by-products generated by specific food sectors to engineer new materials. Through his project *Blood Related*, Dutch designer Basse Stittgen focuses on the billions of liters of animal blood discarded by slaughterhouses every year. Stittgen investigates the potential to engineer a sustainable material from this industrial waste with which he creates a series of poetic objects that explore the different cultural associations towards blood. Similarly, French designer Marlène Huissoud works with the by-product of harvesting honey (propolis) as her raw material and processes it similarly to glass, creating a series of vessels for her collection *Of Insects and Men*. In a textile-based approach, Italian company Orange Fiber tackles the more than 700,000 tons of citrus waste produced in Italy by producing a silk-like cellulose yarn created from the by-product of orange juice production ('pastazzo'), which can then be blended with other materials.

These are but a few examples of how food waste can offer completely new possibilities and challenges to designers and makers of the future. However, there has also

Marlène Huissoud is interested in insects as co-partners in the design process. She treats propolis similarly to glass for her Bee Vessels.

Utilizing surplus milk from the dairy industry, Tessa Silva is investigating milk proteins as an alternative to oil-based plastics.

been a recent growing interest in using technology to process food waste in order to substitute unsustainable, unethical or scarce materials. Plastic is one of the most contentious materials on our planet and one that we excessively rely on. In marine environments, a single plastic bottle can take up to 450 years to fragment into microscopic pieces, which never disappear. Different laboratories across the globe are already beginning to understand the potential of using local food waste products such as starch, coffee grounds or plant cellulose to create durable and sustainable bioplastics.

An example of this is the Italian Institute of Technology in Genova, which recently patented a bioplastic made entirely from unsold artichokes from Genova's market. It is now used in fabricating the traditional partitioned inner packaging used in fruit and vegetable crates.

In terms of ethics and sustainability, the fashion industry and its production of animal leather is also problematic. More than a billion animals are slaughtered every year simply to produce leather, the cleaning process of which produces around 650 million kilos of CO^2.

In response to this, companies such as Ananas Anam make use of agricultural by-products to develop alternatives to leather. Their product Piñatex, a leather-like material fabricated from pineapple leaf fibers in the Philippines, has recently been used in fashion prototypes by brands such as Camper and Ally Capellino.

Both Piñatex and Genova's artichoke bioplastic are alternatives to existing man-made materials, but researchers are also exploring the potential of mining and processing food waste to generate pure raw materials that are generally found on earth. The ceramics lab at the Colorado School of Mines is a pioneer in developing ways of making glass by extracting raw materials such as silica or limestone from food waste including eggshells, banana peels or rice husks. Similarly, UK-based PlasCarb is investigating ways of using anaerobic digestion to convert food waste into biogas,

which is then processed through a low-energy plasma reactor that generates graphitic carbon and hydrogen.

Be it through mining food waste for minerals or making use of food by-products to engineer new materials, the possibilities that food waste offers—in terms of material innovation and exploration—are vast. Moreover, in a highly demanding, fast-paced world, designers and engineers are already being faced with the challenge of scaling up these material alternatives and processes to fit global demands. Not only will it be important to embrace and find opportunities in the current and future overload of waste, but, more importantly, it is crucial to begin devising new systems in which there is no food waste at all.

PRODUCT

FUEL YOUR DAY AND CITY TOO

BIO-BEAN IS POWERING DOUBLE-DECKER BUSES (AND CITIES) WITH COFFEE GROUNDS

TEXT BY
ADRIANA KRASNIANSKY
IMAGES COURTESY
BIO-BEAN

Cities cover just 2% of the Earth's surface, but in that 2%, they hold 54% of its population and consume over 75% of its natural resources. The world's cities produce well over 1 billion tons of garbage annually, 9 million tons of which comes from coffee.

Yes, coffee, the figurative fuel of the urban grind, is a significant contributor to global environmental impact. 2.25 billion cups of coffee are consumed around the world daily, and their grounds and other by-products are great feeders of city landfills. Consumed (and wasted) by homes, restaurants and offices alike, in a first-of-its-kind 2017 study on food waste by the Natural Resources Defense Council, coffee was found to be the single largest source, by mass, of food waste in the three American cities tested, New York, Nashville and Denver. Its impact isn't in volume alone—once in landfills, coffee decomposes to produce methane, a greenhouse gas with 30 times the global warming capacity of carbon dioxide.

In our coffee trash, however, there is treasure: because coffee beans are only processed to extract taste, the remaining grounds retain valuable chemical compounds. In chemist's terms, coffee grounds are highly calorific, meaning they have high concentrations of stored energy that can be released when burned; at 5,000 kcal/kg, they hold more potential energy than wood (2,500 kcal/kg) or even brown coal (3,500 kcal/kg). Such was the realization of University College London architecture student Arthur Kay, prompting him to experiment with converting spent coffee grounds into commercial fuel. In 2013, he founded bio-bean, the world's first coffee-fueled energy firm designed to power full cities.

At bio-bean's 20,000-square-foot production facility in Cambridgeshire, England, over 50,000 tons of coffee grounds from London and beyond are processed to extract their highest-energy oils—about 15–20% of the grounds' total oil content. These oils are combined with other solutions to create a "B20" biodiesel that can be used to power machines, cars and even double decker buses. So far, the company has produced 6,000 liters of coffee oil; globally, this oil has the potential to produce over 720,000 tons of biodiesel each year.

The remaining 80–85% of coffee ground oil that cannot be extracted is dried to create biomass pellets, a greener alternative to wood chips. bio-bean also produces Coffee Logs, a carbon neutral replacement for wood for home fireplaces and stoves. Each Coffee Log is made from the grounds of 25 cups of coffee and contains 20% more energy than wood—meaning it burns hotter and for a longer duration. Given their strong aroma, the logs have inspired a culinary curiosity in coffee-smoked meats, while also receiving high praise from users whose fireplaces potpourri the entire home to smell like a fresh cup of brew.

What makes bio-bean different from academic studies and CSR initiatives (Starbucks and Nestlé both have their own internal coffee recycling programs) is its commitment to working within a city's existing energy and waste infra-structures. Waste management partners undertake all ground collections on bio-bean's behalf, and businesses such as Costa Coffee assign their locations to bio-bean's collection routes, which include coffee shops, offices, transport hubs and food factories across the United Kingdom.

In a world where cities are slowly beginning to assume responsibility for their waste (paper cup taxes and business recycling laws signal promising change), it's important to account for the hidden waste we produce: the by-products of food processing and preparation that we never see as they travel directly from latte station to landfill. bio-bean reminds us to consider the potential of our culinary trash—fuel for our bodies, and for our cities too.

PRODUCT FIGHTING FOOD WASTE WITH FOOD WASTE
APEEL'S PLANT-BASED COATING COULD REVOLUTIONIZE HOW WE PREVENT AND UTILIZE FOOD WASTE

TEXT BY ARIEL LAUREN WILSON
PHOTOGRAPHY BY MOLLY MATALON

In the half-million year history of people searching for ways to extend the shelf life of food, the most recent breakthrough is one you've likely never even heard of. Apeel, a plant-based coating developed by California-based startup Apeel Sciences, wants to claim its place in the food history pantheon right next to refrigeration, canning, pasteurization, curing, smoking and fire.

The way Apeel works is simple: "We use food to preserve food," says CEO James Rogers. The product is a semi-permeable coating that delays produce spoilage by slowing down the rate at which moisture escapes an avocado, say, and oxygen enters. It's invisible, odorless, tasteless, "generally recognized as safe" by the FDA and completely made from plants.

Employing fruit and/or vegetable byproducts—think skins, pulps, seeds and stems of anything from tomatoes to grapes—Apeel extracts what they want (primarily lipids) by basically expediting the composting process with additional heat, pressure and mechanical agitation. The company eventually transforms their desired extracts into a fine-tuned powder cocktail (there are different recipes for different kinds of produce) that, when mixed with water, farmers, packers, distributors or other players along the value chain could apply to their produce as part of their existing washing and packing workflow.

If even just in trials, Apeel's effect to date has been dramatic.

"It's worked on every [produce type] we've tried so far," Rogers says. For example their first commercial avocado product doubles shelf life across all environments; in the lab they've tripled shelf life for produce across a dozen categories and "have a pathway" for quadrupling it according to Rogers.

If so, then in theory, he believes Apeel could ultimately replace the entire cold chain from field to plate—a staggering proposition to say the very least.

What's perhaps easier to envision in the near future is Apeel maintaining produce quality while mitigating our systemic food waste problem. "We're only as good as the product starts," Rogers says. He believes that if applied after harvest at the farm, Apeel can help preserve fruits and vegetables when they're ready instead of continuing the current industry status quo of prematurely picking produce so that it ripens in transit. Consequently, the produce will be more attractive and last longer on shelves and in people's kitchen, presumably decreasing grocery store and home waste. More broadly, Apeel is currently working with small-holder farmers in food insecure regions of Kenya and Nigeria to help them preserve essential staples like cassava—a program they are working on with the Bill and Melinda Gates Foundation.

It's still too soon to say what Apeel's overall impact might be, but if it realizes its promise, we'll remember the late twenty-tens as the dawn of a new chapter in food preservation history.

PRODUCT
PLENTIFUL'S RESERVATION APP IS DESIGNING DIGNITY INTO THE CHARITABLE FOOD SYSTEM

YOUR RESERVATION IS CONFIRMED

TEXT BY
MARTELLE ESPOSITO
PHOTOGRAPHY BY
ANTONIO CHICALA

Standing in line for hours for dinner is not ideal. In New York, diners often brave inclement weather and daunting wait times for their meals. Unlike the diners who are serviced by a handful of apps like OpenTable or Resy to streamline their restaurant experience, diners that rely on the City's food pantries often have no choice but to wait. With the launch of Plentiful, an Android app and SMS reservation system for food pantries and their clients, a group of charitable organizations is hoping to change things by designing dignity into a service fraught with stigma, inconvenience and inefficiency.

While Plentiful seems straightforward, it represents a transformation in thinking about charitable food. Bob Shaver, Associate Principal at Redstone Strategy Group and strategist for Plentiful, reiterates a common assumption with social services, "We assume that if people need something, they will come and get it." Essentially, they'd wait in long lines, make the trek to the service, even miss work. The New York City Food Assistance Collaborative, a group of charitable organizations and public partners with funding from the Helmsley Charitable Trust, saw an opportunity to improve equity and efficiency in the charitable food system by challenging this assumption and focusing on the pantry client experience.

It's not that pantries were uninterested in making better client experiences. Shaver notes, "The number one thing we hear from pantry directors is that they want their clients to feel welcome." But due to organizational capacity limitations, many pantries lacked the client data to meet their needs. There was no way to know who was coming in each week, if they were the same people as last week, where they were coming from, or their household size.

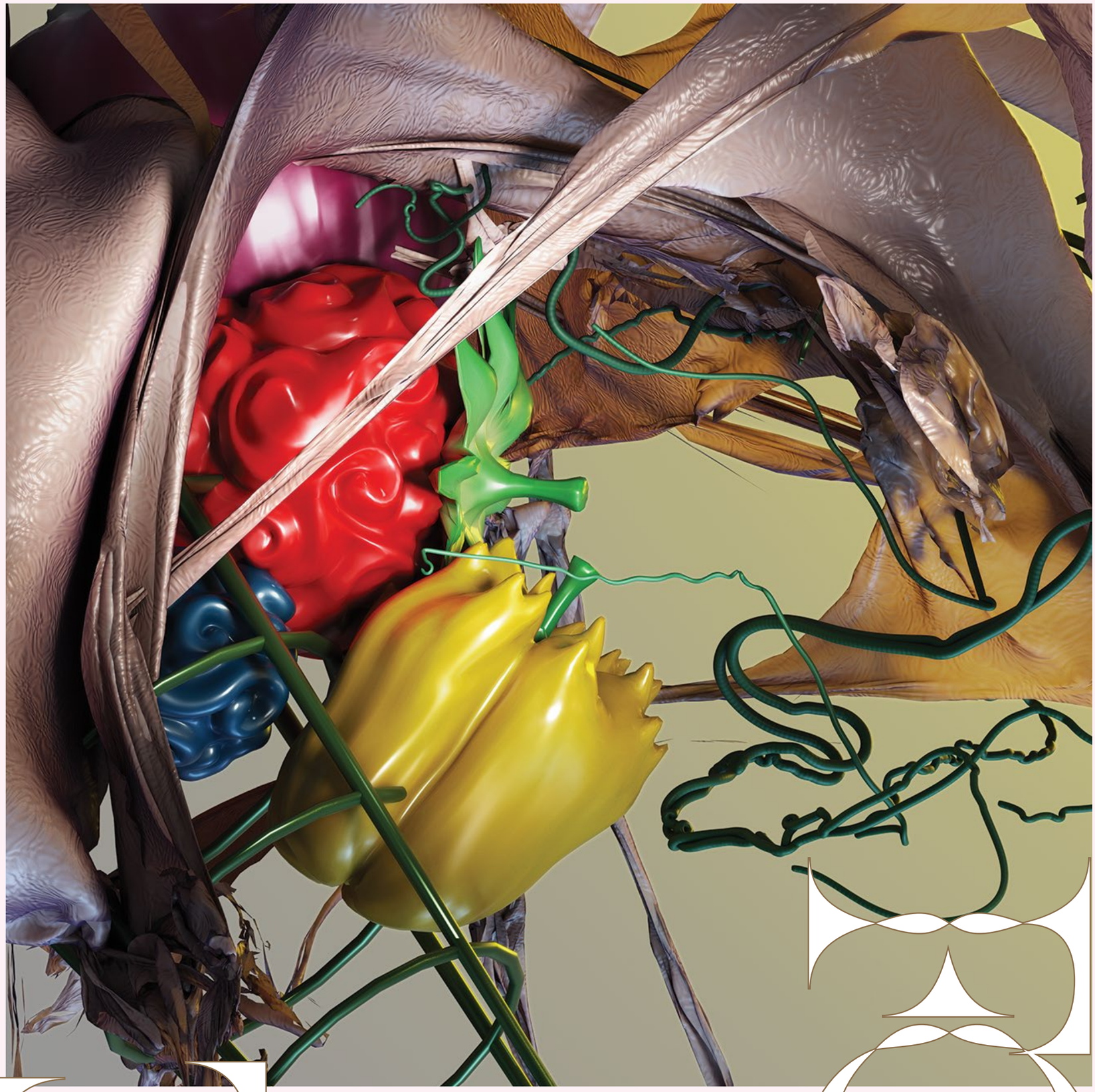
The Collaborative was inspired by retail's dual approach of improving customer experience and collecting consumer data with an app. They settled on a technology-supported reservation model because it allowed for easy collection of client data, was cost-efficient and scalable, and enabled a more dignified client experience. It gave clients autonomy to choose a pantry, agency to make and change reservations minutes to months in advance, the ability to communicate

directly with pantries, and assurance of receiving food with a short wait. Clients have the option to engage using the app or by responding to a series of prompted text messages.

Dignity is also central to Plentiful's brand and user interface. In partnership with digital design studio Big Human, the Collaborative created a simple platform with visuals and messages that intentionally avoided stigma and focused on signaling a trustworthy and welcoming service. It was never going to be "the pantry app."

Plentiful's New York City adoption lead Bryan Moran highlights some of Plentiful's early successes, "We have seen client wait times drop from an average of at least 30 minutes to 4 minutes using Plentiful." Offered in nine languages, Plentiful also breaks down language barriers and makes it easier to communicate delays or disruptions in pantry service. Pantries can also adequately plan for the number of clients each day, so they don't run out of food. Since its initial launch at three New York City pantries in December 2016, Plentiful has expanded to 162 of the approximately 600 pantries across the city, servicing over 130,000 clients.

Plentiful plans to expand to more New York City pantries and experiment with sustainable business models for other markets in the United States, bringing dignity to the pantry experience across the country. The Collaborative also sees a potential opportunity to revolutionize the food procurement side of the emergency food system by integrating Plentiful data into processes for more efficient, less wasteful on-demand food distribution.



What's Architecture Got To Do With It?

Text by Paula Petkova
Art by Team Rolfes

The UN Food and Agricultural Organization estimates that we will need to produce 70% more food by 2050 to feed the world's expected 9.6 billion people. The presumed solution is to intensify agriculture. Truth be told, the earth produces a gargantuan agricultural surplus.

This surplus, however, is lost or wasted at every stage of the food system. Wonky fruit is discarded by farms, food is spoilt along its distribution path, and overzealous portion sizes in homes and restaurants end up on a rubbish heap. We need to reframe the question of feeding people from how to produce more food, to how to waste less food. This challenge is purpose built for architects and urbanists.

Whilst chefs, scholars, agri-businesses, technologists and policy makers have all taken a seat at the table to tackle the challenge of food waste, architects are conspicuously absent. Some might argue that waste reduction is more a cultural or political predicament than an architectural one. But, as an applied anthropologist working within a global architecture practice, it is abundantly clear to me that architecture holds the key. Since the vast majority of food waste occurs in cities, and architects furnish cities with buildings that are complicit in our scandalous culture of waste, architects ought to translate waste reduction practices into spaces—spaces that discourage surplus purchasing, spaces that expose wasteful practices, and spaces for collective cooking and dining which optimize the use of perishable ingredients.

Food has become a hot topic in architectural faculties and firms since the 90's. Yet the focus has been disproportionately focused on food production rather than sustainable food distribution or consumption. Architectural renders are testament to this agrarian zeitgeist. Community gardens, rooftop farms, urban orchards and apiaries are cropping up in renders of future buildings and the spaces in between them. Agrarian architecture is often packaged as part and parcel of the industry's attempt to address the UN's Sustainable Development Goals that champion food resilience in the face of food insecurity, anxieties about agribusiness monopolization and climate change. However, the sustainability arguments behind agrarian architecture are rendered all but meaningless if strategies to reduce food waste are not incorporated.

Take, for instance, Sasaki Associates' masterplan for Sunqiao Urban Agriculture District on the edges of Shanghai. Urban farming in all its contemporary permutations—hydroponics, aquaponics, vertical farming—sit side by side with more traditional community allotments. The design is a veritable platter of engaging and educational food production programming. It ticks many agrarian architecture boxes. The walkable food market quarter is an antidote to the sprawling urban conurbations that have divorced people from the realities of food systems and the precious resources at stake. But, nowhere in the design do the architects address the comparatively unsexy topic of food waste—how to mitigate it, redistribute it, turn it into compost, biofuel or even construction material. Lo and behold, Shanghai has the highest rate of food waste per capita in China. Solid food waste accounts for 71% of Shanghai's municipal waste, compared to 22% in New York. Suffice it to say, reducing food waste would be a more efficient strategy towards achieving food sustainability in China's most populous city.

Why do architects and urban designers overlook food waste? Part of the answer is that food waste suffers from an image problem. While edible landscapes and fruitful architectural topographies are seen as tools of sustainability, place-making and catalysts for community conviviality, the architectural treatment of food waste is seen as the domain of waste management. We need to move the needle from reactive waste management to proactive waste reduction, or what I call food conservation architecture. From the urban scale of neighborhoods, to the architectural scale of supermarkets and kitchens, food conservation architecture comes in different shapes and sizes.

Planning creates a spatial blueprint for consumer behavior. By mid-century, a change was underfoot in the way we shop for food. The synchronicity of post-war modernist development and the democratization of cars paved the way for supersized supermarkets; cannibalizing convenience grocery stores en route, and churning out food waste at an unprecedented rate by promoting excess inventory and excess purchasing. The economies of supermarket scale allowed the prices to drop, the dizzying choice nudged impulse purchases and the adjoining carparks removed the logic of buying only what could be comfortably carried home. Planning for food conservation demands a more fine-grained urban fabric that is walkable and mixed-use. It demands environments that encourage people to shop in smaller neighborhood shops and less inclined to drive to big box stores and buy in bulk. These principles are the cornerstone of New Urbanism which has dominated western schools of urban thought and practice since the 90's. Ellen Dunham-Jones, a disciple of New Urbanism, has written and lectured extensively on the opportunities of retrofitting sprawl into walkable districts that cultivate conscious consumers.

LEFT Urban arboretums and a science museum are the cornerstones of Sunqiao's agricultural research core. Image courtesy of Sasaki.

RIGHT Sasaki Associates' masterplan for Shanghai's Sunqiao includes integration of vertical farming systems. Image courtesy of Sasaki.

Food waste is fundamentally linked to consumer demand. Reducing food waste thus requires changes in the way we value and consume food. With the consumer trend for buying everyday essentials going online, there is greater appetite for offline food shopping experiences—reflected in the renaissance of the specialty food store. The return of the neighborhood greengrocer, butcher, fishmonger and baker plays a fundamental role in reducing waste because it creates the space for the exchange of knowledge between buyer and seller. These quotidian interactions are crucial to changing the way we interact with and value food. Whilst the food that sits on supermarket shelves is divorced from the human labor involved in its production, packaged in misleading 'best by' labels and grouped in arbitrary quantities, the interpersonal interactions within neighborhood shops remedy these issues. Interactions within neighborhood shops transform scan-and-bag transactions into moments of value creation that imbue food with a greater value.

Ebenezer Howard, the founder of the Garden City Movement, was an unlikely frontrunner of the co-(mmunal) phenomenon that is sweeping the industry. He proposed houses with common gardens and co-operative kitchens as early as 1898. Since then, the logic of communal kitchens has manifested itself across the world. From Russia's kommunalkas, to Peruvian comedores populares, Quebecoise regroupement des cuisines collectives, Mexico City's comedores comunitarios and Japan's kodomo kitchens, communal kitchens exhibit the potential of sharing food resources across geographies, generations and income brackets. Based on her global survey of communal kitchens, the Spanish architect Anna Puigjaner writes eloquently about the possibility of *Kitchenless* housing typologies, both in freeing us (notably women) from the Sisyphean domesticity of kitchen maintenance, as well as the manifold benefits of sharing food resources: providing low-cost meals, enabling social integration and, of course, reducing food waste.

Where are we now?

The staggering data around food waste and the catalogue of environmental, social and economic ramifications, has finally captured the headlines. Food waste awareness campaigns, piecemeal initiatives and policies now emerging are encouraging. But there is only so much weight that campaigns, pop-ups and policies can carry. People don't want messages, they want meaningful interactions that challenge the status quo and change attitudes. Architecture can provide such interactions.

Of course, architects cannot solve the problem of food waste single-handedly. They must collaborate with other disciplines. Luckily, this is something they excel at. Contrary to the starchitecture discourse which paints architecture as the act of a singular hand, few professions are as collaborative. What is more, architects speak the language of multiple bottom lines—financial, environmental, social—and have the ear of many different stakeholders. This complex web of knowledge and connections puts them in the right place and the right time to jump start the food conservation movement. This is not a call to arms, but a call for tracing paper and fine point pens.

Sunqiao positions itself as a "living laboratory" for urban agricultural innovation and education. Image courtesy of Sasaki.

COLD SHARES: COULD COMMUNITY FRIDGES BE A TRIUMPH OF THE COMMONS?

Text by NICOLA TWILLEY
Photography by COREY OLSEN
Set by MEGAN KIANTOS

Freddie is based in Brixton, in South London. He likes cake, hates waste and has a couple of thousand followers on Twitter, where he can't resist a good food pun. He's also a fridge—specifically, The People's Fridge—and he's just celebrated his first birthday, having opened his doors in February 2017.

"We had an official launch party," said Rebecca Trevalyan, Freddie's spokesperson and Head of Outreach at the Impact Hub Brixton, a co-working membership organization. "Someone from the council cut a ribbon, and there were talks and delicious food, and then everyone took selfies with the fridge." The day after the launch party, Trevalyan opened her inbox to find thirty emails from people as far afield as New Zealand, all wanting to start a community fridge of their own. "We just got a tremendous amount of press," she explained.

Freddie may have been the first community fridge in London, but he's since been joined by four others around the city, and dozens more across the United Kingdom. "It's exploded," agreed Trevalyan, noting that celebrity chef Jamie Oliver has jumped aboard, bringing along his sponsors, British supermarket chain Sainsbury's, with a pledge of up to £1 million in grants to groups around the country that want to launch a community fridge of their own. In July 2017, the social enterprise foundation Hubbub announced it was forming the world's first Community Fridge Network, with the goal of reaching seventy sites by 2020. Liberated from the kitchen, this once humdrum household appliance seems to have captured the national imagination: Hubbub estimates it currently receives more than fifty inquiries a month from student groups, shop owners, politicians and nonprofits alike.

The world's first community fridge made its debut five years ago, in Berlin, Germany. After his documentary on global food waste, *Taste the Waste*, came out in 2010, filmmaker Valentin Thurn decided to do something practical about the 176 lbs of food each German throws away on average each year. "The fridge is a kind of mood pharmacy," Thurn told Deutsche Welle, Germany's public broadcaster, in 2012. "We fill our refrigerators with stimulating, soothing and all sorts of foods," he continued, confessing to his own habit of succumbing to impulse purchases, buying more than he needed and stashing it in the fridge—a psychological as well as physiological buffer zone that merely delayed its inevitable journey to the trash can. Thurn launched a peer-to-peer food-sharing platform later that year, based on the concept that anyone with surplus food should be able to donate it, and anyone who could use it should be able to take it.

Foodsharing.de caught on quickly: within the first twelve months, the site had signed up 30,000 members who had collectively saved nearly 30 tons of food. But, almost immediately, it ran into a logistical problem: how to coordinate supply and demand without a place to store food. Thurn had labeled the refrigerator as the culprit behind Germany's food waste problem, but his solution turned out to require yet more refrigerators. In 2013, under the foodsharing.de umbrella, Thurn established the FairTeiler network: a series of publicly accessible fridges, hosted by members of the network or supportive local businesses. On an individual level, the refrigerator's time-distorting superpowers—its promise to save food for some other day—might enable waste, but, within the community at large, the fridge served as a bridge, filling the geographical and temporal gaps between surplus food and its eaters.

Over the following years, the idea of the community fridge began to spread. In spring 2015, in Galdakao, a small town on the outskirts of Bilbao, Spain, volunteers put a large white fridge on a sidewalk, built a wooden fence around it, and launched it as the country's first "solidarity fridge." By 2016, there was a community fridge in Frome, a historic market town in Somerset, England, and one nicknamed *namma maram* or "tree of goodness," in the port city of Kochi, in Kerala, India. Curiously, it was the latter that provided the inspiration for Freddie's founders: in May 2016, Impact Hub Brixton convened a meeting of activists from around the borough to discuss what was missing from the local food system, and someone mentioned an article they'd read about a community fridge in India. "Basically, we were all like, Oh, we should do that—that looks great!" said Rebecca Trevalyan. "Why doesn't that exist already?"

On a Tuesday morning in July when I visited, Freddie's shelves were filled with day-old sourdough bread, four zucchini, and a sack of potatoes. "That's pretty normal," Trevalyan told me. "We did have some truffle oil in there at one point, and a Christmas pudding in April, which was weird." Most of the food comes and goes within twenty-four hours, according to Trevalyan, and most comes from businesses rather than individuals. A nearby branch of Pret-a-Manger drops off leftover sandwiches at the end of the day, and a local cinema will put in pastries, "like homemade almond and orange cake and big piles of brownies and stuff," Trevalyan said. "They don't stay around very long."

Frequently, the foods in the fridge don't actually need to be refrigerated—Freddie is as likely to contain cans and cereal boxes as milk—and Trevalyan told me that she'd love to set up a "People's Pantry" next door, when time and funding permit.

Similarly, the Impact Hub team hopes to conduct a detailed survey to see exactly who is using the fridge. The group spent time talking about the fridge with local traders, restaurants, and food businesses to secure their participation ahead of its launch, and Trevalyan said that she's since personally met and talked to lots of users. "It ranges from people who work in the area who are just popping by to get a loaf of bread, to families who come along to see what fruit and veg is in there, because food banks don't have fresh food generally," she told me. Despite this anecdotal evidence that the food in the People's Fridge is, in fact, going to the people who need it most, Trevalyan is quick to point out that it "is not a solution to food poverty"—and nor is it intended to be. Plastered to Freddie's front is a sign saying that he is a "Judgment-Free Zone," meaning that there is no need to show proof of hunger or need to take from the fridge. Similar principles inform the majority of Europe's community fridges. "It doesn't

matter who takes it—Julio Iglesias could stop by and take the food," Álvaro Saiz, organizer of Galdakao's Solidarity Fridge, told The Guardian. "At the end of the day, it's about recovering the value of food products and fighting against waste."

In India, which is home to a quarter of the world's undernourished population and where fewer than thirty percent of families own a refrigerator, community fridges are equally popular, but operate on a slightly different basis. Decorated with garlands of marigolds, a steel fridge on the edge of a busy Mumbai street is typical. It offers donations of homemade dhal, vada pav (fried potato sandwiches) and poha, or flattened rice. Its organizer, a local community group, wanted "to create an atmosphere where people could live with dignity and weren't forced to beg." Reducing food waste was a secondary goal.

But while the logic of the community fridge is immediately appealing in either context, actually setting one up is significantly easier in India than in Europe, where public health authorities have generally struggled with a community fridge's inherent lack of ownership and distributed management structure. In Berlin, food inspectors declared that the city's FairTeiler fridge network posed a health hazard in early 2017, reporting "unhygienic conditions," including unpackaged bread. At least one of Berlin's twenty-five community fridges shut up shop in response. In Brixton, Trevalyan told me that Freddie's intended location, on the street, had been vetoed by the council—he now lives inside a local event space, and is locked up at night. Raw meat, fish, and eggs are all excluded from the fridge due to fears of contamination, and cooked food can only come from registered food businesses, rather than individuals.

A team of volunteers check the food, monitor the temperature, and clean the fridge every morning and every evening, and both food donors and food users have to sign a logbook so that the council can see what food has come in and gone out, and when. "They want full control," explained Trevalyan "They say, if you're measuring your risks, you're managing them. Whereas with this, the point is that people manage themselves."

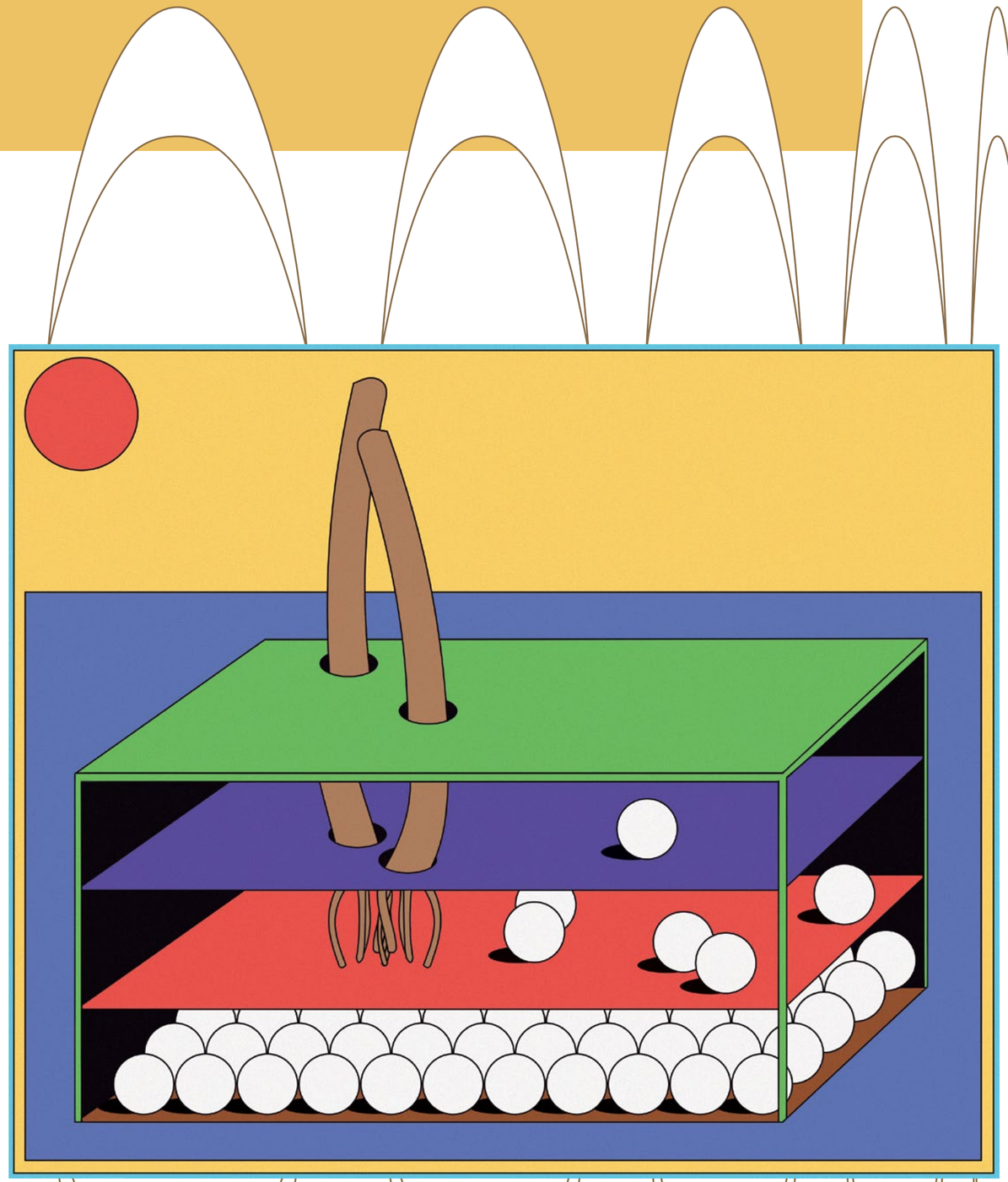
To anyone who has had the misfortune of having their lunch stolen from the office fridge, or witnessed the inability of a dorm full of students to clean up spills and sticky patches in their shared kitchen, this idea—that people will manage themselves—will likely set off alarm bells. Certainly, to me, a shared fridge seemed like a tragedy of the commons waiting to happen. But that hasn't been the case, according to Trevalyan. "People always assume it will be far worse than it is, from my experience," she chided me. "Good social design is getting people to act in the interest of the collective without explicitly asking them to," she explained. "And I think if you design services like this correctly, with the kind of storytelling and signage and subtle nudges to make people act the right way, then they generally do." In Freddie's first few months, Trevalyan says she's already learned valuable lessons about the scale and geography at which a community fridge operates best, which is "hyperlocal—like a one- or two-minute walk, max." She's found that, at the end of a long shift, workers in local food businesses are unlikely to walk further than that to drop off excess food. Similarly, within the first few months, the team redesigned the fridge logbook signage to make it even simpler and less wordy. Basically, people will not do anything unless you make it really easy and really obvious," Trevalyan said.

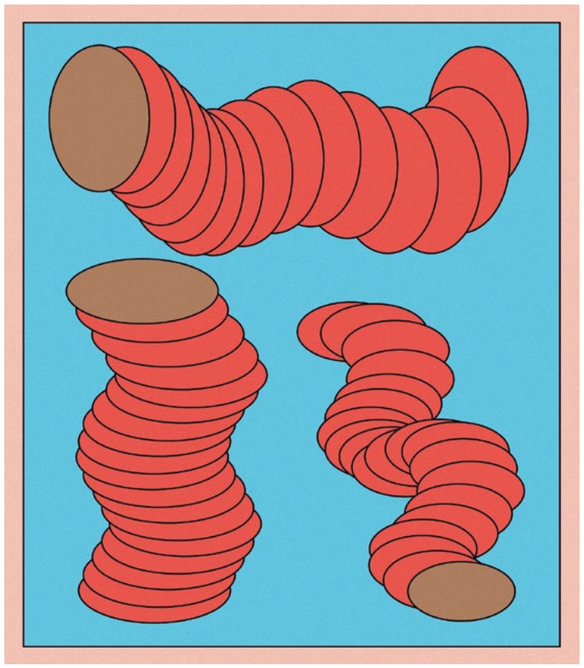
For Trevalyan, who also runs another sharing initiative called The Library of Things, which loans out useful items such as power tools, this is perhaps the most exciting aspect of Freddie's impact. Helping reduce food waste, helping those in need find food—these are important and valuable achievements in their own right. But figuring out how to build and maintain a community-owned, shared resource? "That," she told me, "would be powerful."

Designing Soil

Art by Cynthia Alfonso

Text by Sue Pierre





Soil is a treasure often mistaken for dirt. It masquerades as inert and mundane, an afterthought to the rest of a beautiful landscape. But soil, the stuff that accumulates beneath the forest canopy, under the rhythmic growth of perennial grasses, and between cracks in pavement, is a natural resource like oil and ore. However, unlike other natural materials that society needs, soils are a resource that can be replaced within our lifetimes and moreover, soils can be designed.

This last point is one to sit with; its profundity comes like a slow drip. For centuries, humans have known that in order to grow enough food to feed a family, a community, or a civilization, we need soil that is rich in the nutrients plants need for growth. Such soils are not as common as we would like, so humans have learned to supplement what nature does on its own. Over time, the art of building soils from scratch has been refined into a science. Today, the process of building a rich soil from its starting materials, what we call "composting," has revolutionary potential.

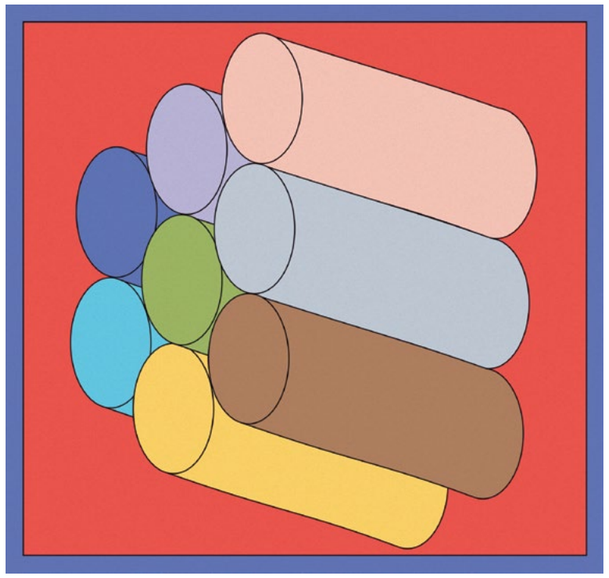
In the most basic sense, compost is an assemblage of elements that move around. The key parts of compost begin as plant and mineral waste materials. A voracious community of bacteria, archaea, and fungi then get to work, breaking these materials down and, over time, stripping them down to smaller molecules that plants can take up. People compost using several different techniques—from the backyard heap to the high tech bioreactor. But the fundamentals remain the same: scraps are mobilized into high quality nutrients with specialized groups of microbes doing the heavy lifting.

What many don't recognize is that soil, like any other natural resource, has a social and political life all its own. While oil reserves or deep mines seem like more obvious parts of the global economy, soil plays an undervalued role. Fertile soil props up agriculture and supports the economies of entire regions of the globe. Organic matter in soil, like that produced from composting, sequesters carbon from the atmosphere and mitigates climate warming. As governments around the world face the human, environmental and economic costs of climate change, various groups are turning to soils for solutions.

Pashon Murray is the co-founder and CEO of Detroit Dirt, an urban composting company with a mission for closing the food waste cycle in cities. As a child, watching tons of food fill the landfill her father owned didn't sit well with Murray. This experience gave rise to her radically simple vision for a more sustainable society. "I am providing a vital resource to make new market spaces in Detroit," said Murray. That vital resource is soil, which Detroit Dirt makes in large open-air mounds which are built up with food scraps, spent hops from local breweries, and animal manure from the Detroit Zoo. Murray's commitment to urban composting comes from an awareness of our rapidly changing environment. "We need to be replacing topsoil at the rate that it is being lost," she said, referring to the high rate at which fertile soil is being eroded. Murray's vision of expanding urban composting and closing the food waste cycle is not only practical, it's personal. "Knowing that there are people [in Detroit] who look like me, I wanted to lend my expertise to the city," said Murray, a Black woman. Her strides towards a zero-waste Detroit have

connected Murray to the White House, where she presented the Detroit Dirt business plan to President Obama, and to MIT, where she is a current Director's Fellow at the MIT Media Lab. "We don't need to have a $218 billion issue around food waste if we can instead process this material and recover it."

Soils are the biggest reservoir of carbon on earth, far surpassing the capacity of plants and the atmosphere to hang on to carbon. Carbon dioxide can be trapped for centuries in soil organic matter, or compost, by converting carbon-rich plant material



into compounds that are hard for microbes to break down. Researchers across the world are dedicated to understanding the forces that drive the natural formation of soil, and how society can harness those capabilities to create a more sustainable future. In Dr. Whendee Silver's lab at the University of California Berkeley, researchers are exploring how finely-tuned composting, leading to different compost makeups, may be able to help trap more carbon dioxide in grassland soils in California. Through her team's work, policy makers in California's state government may be able to regulate how compost is made and applied, and potentially draw down greenhouse gases from the atmosphere.

Just up the road from Dr. Silver's lab, researchers at the Lawrence Berkeley National Lab (LBNL) are also working on harnessing the regenerative power of soils. The AR1K Smart Farm Project is a unique partnership between LBNL, the University of Arkansas, and Glennoe Farms in Arkansas that aims to "reduce the need for chemical fertilizers and enhance soil carbon uptake. Researchers and farmers are working together to study the roles of bacteria and fungi in soils and monitor fine-scale details about the agricultural environment, such as soil moisture and incoming solar radiation. "Currently, fertilizers and other treatments are applied without scientific understanding or without knowing limiting factors," says Dr. Haruko Murakami-Wainright, scientist at LBNL and a lead researcher on the AR1K Smart Farm Project. Her team is combating a dangerously common idea: 'the more fertilizer, the better,' which, Dr. Wainright says, "increase[s] farmers' input cost, and hurts their economic viability."

Fertilizers are added to commercial farms in quantities well above what the soil can retain, and much of it washes off fields and into waterways, causing huge aquatic die-offs in coastal regions. The AR1K project team is comprised of soil microbiologists, remote sensing experts, statisticians and farm managers who use cutting-edge data-analysis techniques to unite very different types of environmental "big-data," such as microbial genomes and ecosystem-scale carbon dioxide uptake and release statistics. The team has cultivated naturally-occurring microbes in the lab, selecting those that assist crops in accessing nutrients like phosphorus. Future large-scale application of "microbial amendments" to soils could reduce the use of traditional synthetic fertilizers that farmers apply, and abate some of the environmental problems fertilizers cause. Ultimately, Dr. Wainright and her team aim to show that the foundations of sustainable food systems will rely on understanding the soils themselves. "We are hoping that this project will also increase the awareness about soil and its critical function for food security," says Wainright.

The alchemy of soil formation—turning the dead and spent into fodder for life itself—has challenged farmers and scientists for centuries. Though the information we once had about soils is becoming a steady stream of understanding, the depth of what soils can do remains poorly understood. Lessons from the urban composting system and soil systems laboratories may be more related than we can currently imagine, requiring more diverse, interdisciplinary teams of people to press the boundaries of what soil can do. Future cross-disciplinary efforts, where groups like Detroit Dirt and the AR1K Smart Farm team sit at the same table, may provide the space needed to uncover sites of innovation based on the intrinsic properties of soil. Such a leap into untrodden territory |may reveal that as people endeavor to design and build soils, soils may guide new frameworks for human survival.

FRIDGES OF THE FUTURE

TEXT BY JOHNNY DRAIN
PHOTOGRAPHY BY COREY OLSEN

TURN ON, TUNE IN, CHILL OUT

My phone dings with the arrival of a message. It's my fridge. The tomatoes nestled within it are expiring. Three more days, it tells me, and they'll be mush. They would, however, be perfect in a ragu and I've most of the other ingredients needed: the carrot, the celery, the onions, although not the beef, which it offers with one button-click to have delivered to my home tonight, or tomorrow, or the day after. It goes on: it suggests reordering tomatoes and displays via my phone the optimum place to store them, but fewer this time, given that I've left my last few purchases get to this state and had to transfer one recent moldy bunch to the composter.

Since the 1950's, fridges have helped households keep produce fresher and more nutritious for longer and extended the life of leftovers. However, the fridge has also remained somewhat one-size-fits-all: one cavity, one temperature, one humidity. In essence, a big, fairly unnuanced, cool-box. For instance, to keep vegetables tip-top requires a certain amount of moisture, but many conventional fridges are on the dry side, especially if they share an air supply with a freezer compartment. In contrast, meats might benefit from that slightly less humid environment. Eggs don't mind humidity, but they do absorb odors—good and bad—from produce around them. The challenge, then, for designers and engineers is to build fridges that provide flexibility and the best conditions for preserving a range of foods.

For fruit and vegetables—50% of which grown globally gets lost or wasted—"spoiling" is merely part of a timeline that also includes ripening, the passage along which, and that of their neighbors, is hastened by the ethylene gas that many of them give off. A number of companies like OXO and Whirlpool have products equipped with replaceable sachets or panel filters that claim to absorb ethylene while premium refrigerator models from brands like Bosch, GE and Sub-Zero offer built-in technologies that absorb, break down or inhibit ethylene. Sub-Zero's airconditioning-like unit removes ethylene via a set of chemical reactions, along with various microbes. As the company's VP of design engineering Paul Sikir clarifies, "we developed it with a local university who had worked with NASA to demonstrate how they could preserve food longer on space stations. These same basic principles were then used by food suppliers to avoid spoilage in warehouses. We just scaled it down to a very compact system that fits in a fridge." Perhaps the ethylene extracted from one fridge compartment might one day be pumped into another where fruit could be intentionally ripened; no more waiting around for hard pears and plums to sweeten. And the sensors that detect tell-tale emissions of certain gases to alert us to food turning bad might also let us know the optimum time to eat our avocados based on our personalized preferences for firmness.

The Microbial Home concept from Philips Design includes a methane bio-digester kitchen island powered by food scraps and an evaporative cooling larder that doubles as a dining table.

Besides whizz-bang sensors, filters and internet-of-things integration, much cutting-edge research goes into making fridges and freezers more energy efficient. While less exciting, it will be these developments that start to benefit those most in need of food security in Asia and sub-Saharan Africa and the world's expanding middle classes. One beautifully simple, inexpensive refrigeration solution that is already helping rural communities is the clay pot cooler. Consisting of two clay pots separated by a cavity packed with wet sand, it uses evaporative cooling to keep food cool without electricity. It has been shown to reduce diseases due to spoiled food, create work for local pottery-makers, and increase school attendance of young produce sellers by extending the window over which their products can be sold.

Such evaporative cooling systems have also appeared in designs by those questioning whether our reliance on electric refrigeration is entirely a force for good: by allowing us to delegate food preservation—increasingly out of sight—do fridges make us lazy and more wasteful? In 2011, industrial designer Péter Gál collaborated with Philips on a conceptual "domestic ecosystem," *The Microbial Home*, that featured a vegetable-storing evaporative cooler built into the middle of a dining table, bringing fresh produce center-stage rather than buried at the bottom of a fridge. Gál's work also probed how putting home food waste to good use can be made more accessible (although the prime focus should always be on preventing food waste) with a kitchen island that contained a bio-digester for turning organic waste into methane gas for powering other home appliances like the stove top. Similarly, Jihyun David's *Save Food From The Fridge* features five kitchen tools for storing

Clay pots have been used for centuries for storing and preserving foods. Here, onggi earthenware vessels are used to ferment kimchi. Photo by Madison Scott-Clary via Wikimedia.

ICE
LIGHT
WATER

foods outside the fridge in a bid to preserve them better and celebrate their form and beauty. In one, root vegetables are kept fresh by being stood vertically in dampened sand and in another, *Symbiosis of Potato+Apple*, the ethylene given off by apples actually suppresses sprout growth in the spuds that sit beneath them in a darkened maplewood tray. This modular approach of tools with more specific tasks is being echoed by conventional fridge developers too.

Jihyun David's Save Food from the Fridge project keeps produce on the table with (above) the Leafy Base and the evaporative cooling Knowledge Fruitbowl.

Moving away from bulky, white or chrome carbuncles in the corner of kitchens, there is a trend towards smaller, but multiple, below-the-counter refrigerated pull-out drawers. These offer a more tuneable system of holding temperatures and humidities for produce with different requirements and make it less easy to neglect foodstuffs in those hard-to-reach fridge corners. Although there will always be people who want centrepiece appliances, for the most part people want them to be less visible: in many ways the fridge as we know it is disappearing.

Indeed, as a recent inhabitant of a houseboat on London's canalways when my fridge broke—I shorted it, playing DIY—I chose not to replace it. A 30-liter Thermobox, instead, allowed me to keep things entirely chilled during the winter and early spring months (one benefit of the British weather) and modified my purchasing and eating habits in not entirely unpredictable ways. Six months into the experiment, I buy more fresh vegetables more often, more cured and fermented products (yogurt over milk, charcuterie over fresh meat), cook more

Special thanks to Sub-Zero and the staff of their New York City showroom.

precise portions to ensure fewer leftovers, drink more red wine over white, and, regrettably, eat less ice cream. Already fairly hot on not wasting food, I squander even less now and am more mindful of what I buy and how it will be used. (Boat life is conducive to this anyway: what is brought aboard must be taken ashore, in some form, at some point!) As the weather has warmed up, the cool box isn't quite as effective: milk doesn't keep much more than two days. But if I do buy a fridge-freezer, I'll get a small one, largely for drinks, ice, and, obviously, ice cream.

Whatever form they do take, and whether they have the ability to message us and organize our shopping, the challenge remains for designers and engineers is to build food storage solutions that provide flexibility, in keeping with changing lifestyles, and to help us develop habits that ensure we eat more and waste less of the food we bring into our homes.